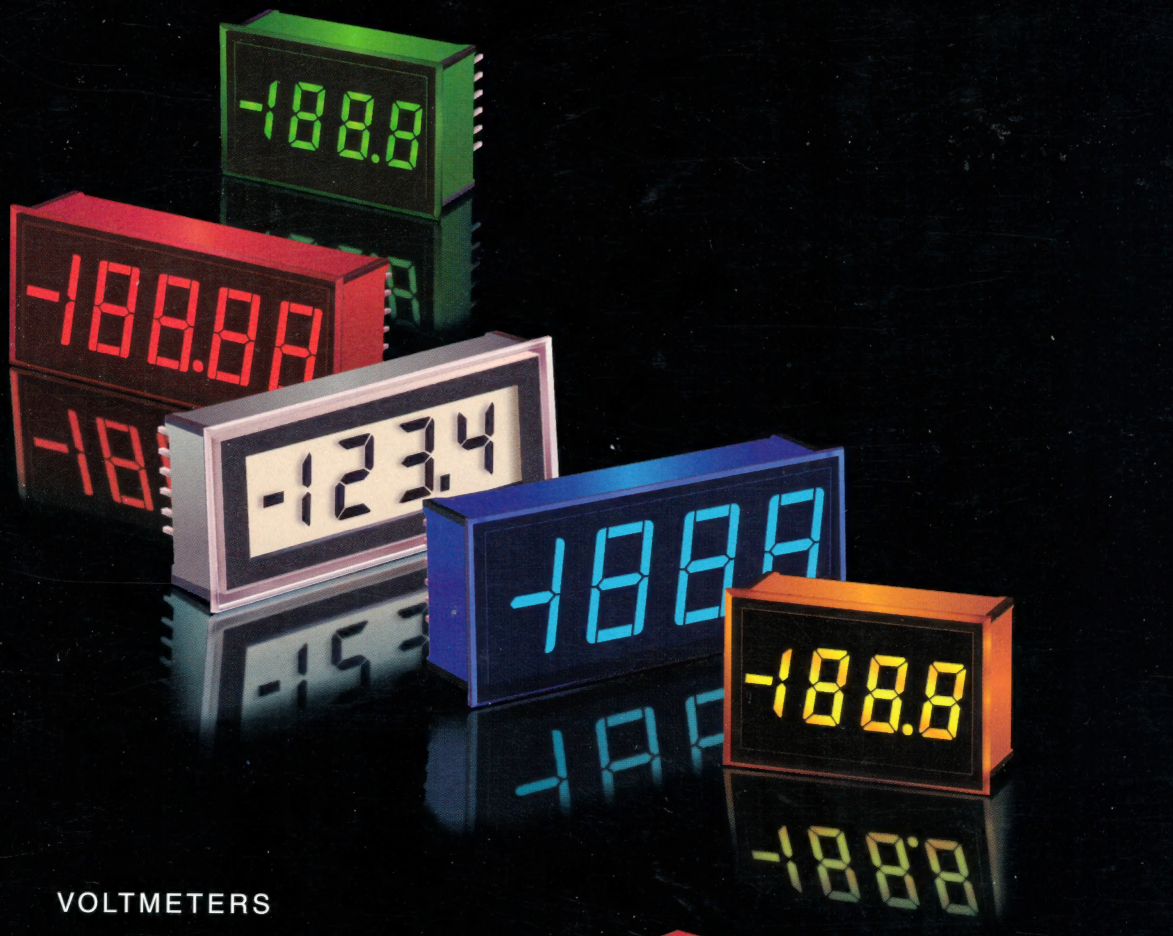
DATEL®

DIGITAL PANEL METERS



VOLTMETERS

2-WIRE METERS

PROCESS MONITORS

APPLICATION NOTES

DATABOOK AND APPLICATION GUIDE

About DATEL

Founded in 1970, today's DATEL is an international electronics manufacturing company that has achieved leadership status in all four of its core product lines: digital panel meters and instruments, switching DC/DC power converters, data acquisition and conversion components, and analog I/O boards for PCI, ISA, VME and Multibus platforms.

All our products are proudly designed and manufactured in our modern 180,000 square-foot facility in Mansfield, Massachusetts (U.S.A.). To serve our international customers, we have wholly owned Subsidiary Sales Offices in Japan, Germany, France and the United Kingdom.

ISO 9001
REGISTERED
MIL-PRF-38534 Qualified

Digital Panel Meters

20 years of designing and manufacturing digital panel meters has not dulled our spirit of innovation. Five years ago, DATEL was the first company to miniaturize both the size and the price of DPM's. Today, we are focusing on specific applications with a new line of 2-Wire Meters that are the easiest-to-use, most affordable digital meters available.

Order Entry

DATEL has direct sales offices in the United States (Mansfield, MA), Germany (Munich), France (Montigny Le Bretonneux), England (Tadley) and Japan (Tokyo and Osaka). We employ an extensive network of field sales representatives and distributors throughout the USA, Canada, Europe, the Far East and other areas around the world.

There are four ways in which to purchase DATEL Panel Meter Products:

- Open an account with established credit
- Bank check or money order
- VISA, Mastercard or American Express credit cards
- C.O.D.

Literature

For copies of new-product data sheets printed subsequent to this catalog or the latest revisions of data sheets contained in this catalog you can:

- Visit us on the internet at **www.datel.com**
- Call us at **(800)233-2765** (USA)
- Call one of our Subsidiary Office Hotlines (see back cover)
- Use our Data Sheet Fax Back Services (see page IV)

Applications Assistance

DATEL employs a large, knowledgeable, patient staff of degreed Applications and Sales Engineers in both our Headquarters and Subsidiary offices. These experienced engineers are always available to answer any questions you may have concerning the selection or use of any of our products. Please do not hesitate to call us.

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Table of Contents

Quick Selection Guides II
Web Site and Data Sheet Faxback III
New Products IV
Display Options and Dimensions V
Quality and Reliability - A Case Study VI

3½ Digit, LED/LCD Display, Digital Panel Meters 1
Selection Guides 1-2
Product Data Sheets 1-3

4½ Digit, LED/LCD Display, Digital Panel Meters 2
Selection Guides 2-2
Product Data Sheets 2-3

2-Wire Digital Meters 3
Selection Guide 3-2
Product Data Sheets 3-3

Process Control Monitors 4
Selection Guide 4-2
Product Data Sheets 4-3

Application Boards and Accessories 5
Introduction 5-1
Product Data Sheets 5-3

Application Notes 6
Application Note Index 6-1

Other DATEL Literature 5-2
Other DATEL Products 5-18
Part Number Index 6-26
Placing an Order 6-27

Quick Selection Guides

DMS Series Digital Panel Voltmeters

Resolution	Display Type ①	Digit Height	Package Size ①	DATEL Series Number	Features	Page
3½ Digits	LED	0.37"/9.4mm	Subminiature	DMS-20PC	Lowest-cost LED meters. 7 LED options.	1-3
		0.56"/14.2mm	Miniature	DMS-30PC	Large LED display. 11 LED options	1-9
	LCD	0.37"/9.4mm	Subminiature	DMS-20LCD	Smallest, lowest-power/cost LCD meters.	1-15
		0.4"/10.2mm	Miniature	DMS-30LCD	Low power. Large digits.	1-21
		0.4"/10.2mm	Miniature	DMS-3019X	Alternate source for DP-650 Series.	1-27
4½ Digits	LED	0.52"/13.2mm	Miniature	DMS-40PC	Scientific-grade accuracy. 5 LED options.	2-3
				DSD-40BCD	BCD input, slave LED display. 3 LED options.	2-15
	LCD	0.4"/10.2mm	Miniature	DMS-40LCD	Scientific-grade accuracy. Low power.	2-9

① See page V for display options/colors and package outline dimensions.

Process Control Monitors

Input	Power Supply	Display Type ①	Display Resolution	DATEL Model Number	Features	Page
4-20mA	Loop Powered	LED	3½ Digits	DMS-20PC-4/20S	The first, loop-powered, LED readouts.	4-3
		LCD	3½ Digits	DMS-20LCD-4/20S	2V loop drop. On-board gain/offset adjustments. DIP switch for 100's of input/readout combinations.	4-6
			3½ Digits	DMS-30LCD-4/20S		4-7
			4½ Digits	DMS-40LCD-4/20S		4-10
	+5V or +7.5-32V	LED	3½ Digits	DMS-30PC-4/20S	4 connections (2 loop, 2 power). 4 LED options. +5-32V supplies.	4-12
			4½ Digits	DMS-40PC-4/20S		4-15
0-5V	+5V or +5-40V	LED	3½ Digits	DMS-20PC-0/5	100kΩ input impedance. 4 LED options.	4-17

① See page V for display options/colors and package outline dimensions.

Plug-On Application Boards

Use With	Function	DATEL Model Number	Page
DMS-20PC/LCD Series 3½ Digit Meters	Multi-purpose: 4-20mA Process Monitoring, Input Attenuation, Decimal Point Placement, Gain/Offset Adjusting, Battery Operation and More	DMS-EB2	5-3
DMS-30PC/LCD Series 3½ Digit Meters	Multi-purpose: Process Monitoring, Input Attenuation and More ①	DMS-EB	5-6
	AC/DC Converter for Operation from AC Line Voltage	DMS-EB-AC/DC	5-9
	DC/DC Converter for Supplies to +18V and 750V Isolation	DMS-EB-DC/DC	5-10
	Accepts Direct Inputs from AD590 Temperature Sensors	DMS-EB-HTB	5-11
	"Self-Powered" 4-to-20mA Measurements	DMS-EB-LP	5-12
	AC-to-RMS Converter for Direct Measurements of AC Inputs	DMS-EB-RMS	5-14
	Accepts Direct Inputs from J or K Type Thermocouples	DMS-EB-TCJ/TCK	5-15

① Also applies to DMS-40PC/LCD Series 4½ digit meters.

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Quick Selection Guides

2-Wire Meters

Input Range	Display Type and Resolution	DATEL Model Number	Features	Page
AC Voltmeters				
85-264Vac @ 47-63Hz	3 Digit Red LED	DMS-20PC-1-LM	"F" model plugs directly into USA wall outlets	3-3
85-140Vac @ 350-450Hz 240-310Vac @ 47-99Hz	3 Digit Red LED	DMS-20PC-2-LM	One device covers two operating ranges	3-4
350-600Vac @ 47-63Hz	3 Digit Red LED	DMS-20PC-3-LM	For 480Vac 3-phase primary power	3-5
AC Frequency Meters				
47.0-99.0Hz @ 85-140Vac	3 Digit Red LED	DMS-20PC-1-FM	The smallest ac frequency meters	3-6
47.0-99.0Hz @170-264Vac	3 Digit Red LED	DMS-20PC-3-FM	For 220Vac applications	3-6
350-450Hz @ 85-140Vac	3 Digit Red LED	DMS-20PC-2-FM	For aircraft and other 400Hz applications	3-6
DC Voltmeters				
+2.00 to +6.00Vdc	3 Digit Red LED	DMS-20PC-3-DCM	Bright red LED's, 80mA max. current at 3.3V	3-9
+4.50 to +19.99Vdc	3½ Digit Red LED	DMS-20PC-0-DCM	Bright red LED's, 13mA max. current	3-8
+6.50 to +18.00Vdc	3½ Digit LCD	DMS-20LCD-0-DCM	The lowest-cost 2-wire meters	3-7
+8.0 to +40.0Vdc	3 Digit LCD	DMS-20LCD-1-DCM	The lowest-cost 2-wire meters	3-7
+18.0 to +50.0Vdc	3 Digit Red LED	DMS-20PC-1-DCM	Reverse polarity protected, 13mA max. current	3-8
+30 to +264Vdc	3 Digit Red LED	DMS-20PC-2-DCM	Reverse polarity protected, 7mA max. current	3-8
–4.50 to –19.99Vdc	3½ Digit Red LED	DMS-20PC-4-DCM	Bright red LED's, 13mA max. current	3-10
–18.0 to –50.0Vdc	3 Digit Red LED	DMS-20PC-5-DCM	Reverse polarity protected, 13mA max. current	3-10
–30 to –264Vdc	3 Digit Red LED	DMS-20PC-6-DCM	Reverse polarity protected, 7mA max. current	3-10
–36.0 to –75.0Vdc	3 Digit Red LED	DMS-20PC-7-DCM	Great for monitoring -48V power buses	3-11

www.datel.com

Four Product Lines
Downloadable Data Sheets

- New product announcements
- Product selection guides
- Latest revisions of all technical literature
- Contact information for reps and distributors
- Email requests for new catalogs

Data Sheet Fax Back

In the USA: Dial (508) 261-2857 and follow the prompts. If you do not know the 5-digit fax code of the data sheet you want, request an index through the faxback system. Fax codes are also listed at the DATEL web site.

In Europe: We use the INFOFAX faxback service. From your fax machine, call:

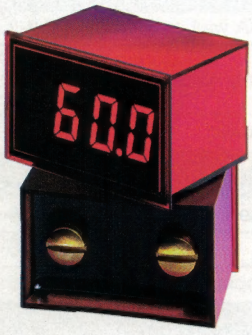
From Germany: 08765-9302-(INFOFAX-Nr.)
From the rest of Europe: 0049/8765-9302-(INFOFAX-Nr.)

If you do not know the 4-digit INFOFAX-Nr., use 2500 as the INFOFAX-Nr. to receive an index of all DATEL documents, or check the DATEL web site.

New Products

2-Wire Meters

The Easiest-to-Use Digital Meters Available • Two Connections – No External Power Required
Small, Rugged Packages with Reliable Screw Terminals • Great Replacements for Analog Meters



Frequency Meters

- Ideal for emergency power equipment
- Designed for 50/60Hz or 400Hz applications
- Large, easy-to-read, LED displays

See page 3-6

DC Voltmeters

- Low prices!
- Negligible power consumption
- Large, easy-to-read, LED or LCD displays
- Monitor all popular batteries or power supplies

See page 3-7

AC Voltmeters

- Monitor voltages up to 600Vac @ 50/60Hz or 120Vac @ 400Hz
- 3-digit readouts; ±1V accuracies
- 140V model plugs directly into USA outlets

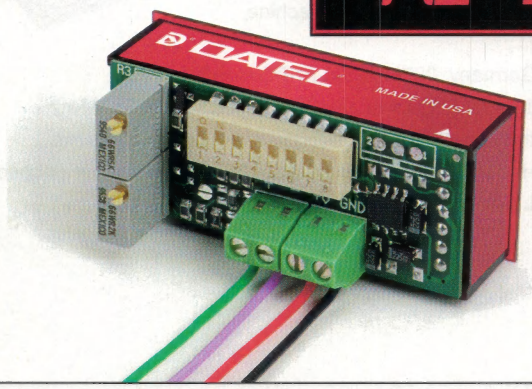
See page 3-3

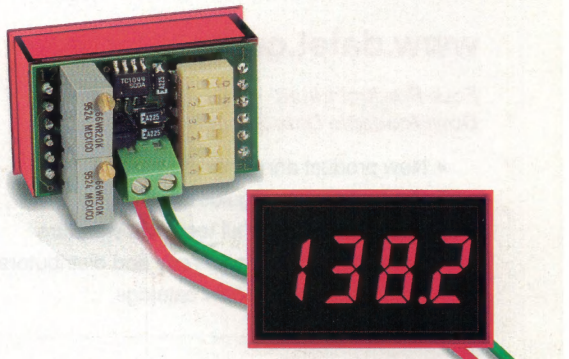
Process Control Monitors

4-20mA with Full-Size LED Display

- First local readout with a full-size (0.56"/14.2mm) LED display
- 4 LED options including low-power and high-intensity red
- 4 connections . . . 2 for loop, 2 for power (+5 to +32V)
- DIP-switch selectable range and decimal points
- On-board span/gain and zero/offset adjustments
- Rugged, vibration-resistant package

See page 4-12





First Loop-Powered LED Meter

- Totally loop powered - no external power supply
- Large (0.37"/9.4mm), bright red, 3½ digit LED display
- DIP-switch selectable range and decimal points
- On-board span/gain and zero/offset adjustments
- Rugged, vibration-resistant package

See page 4-3

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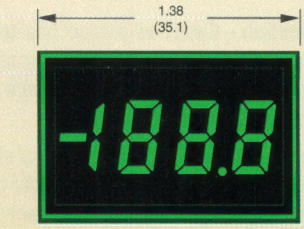
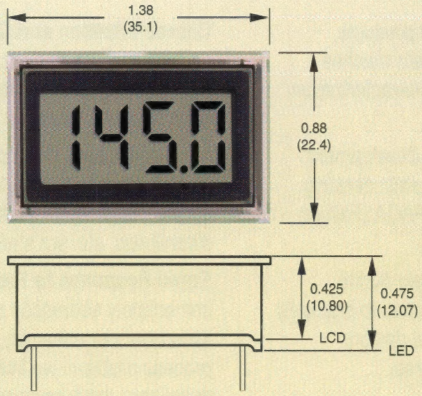
Display Options and Dimensions

DMS-20 Series Meters and Instruments



LED HEIGHT: 0.37 in. (9.4mm)
LCD HEIGHT: 0.37 in. (9.4mm)

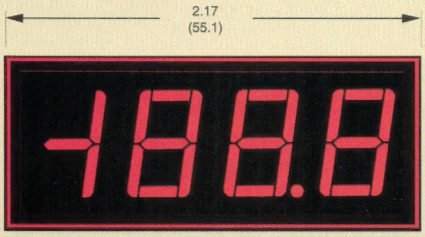
AVAILABLE LED COLORS



This page summarizes the package dimensions and digit heights of DATEL's DMS-20/30/40 Series meters and instruments. Front-view dimensions apply to all products. Package depths apply to standard panel meters only. 2-Wire Instruments and Process Control Monitors have package depths that vary with the product. See individual data sheets for details.

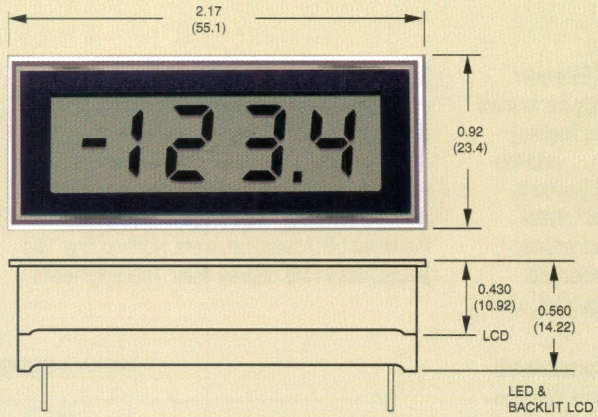
Packages are shown actual size.

DMS-30 Series Meters and Instruments

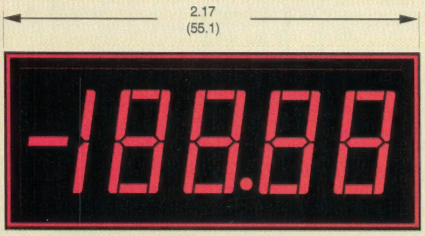


LED HEIGHT: 0.56 in. (14.2mm)
LCD HEIGHT: 0.40 in. (10.2mm)

AVAILABLE LED COLORS



DMS-40 Series Meters and Instruments



LED HEIGHT: 0.52 in. (13.2mm)
LCD HEIGHT: 0.40 in. (10.2mm)

AVAILABLE LED COLORS

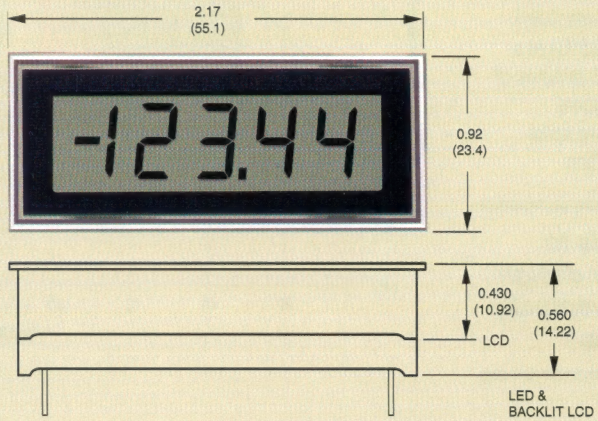


Table of Contents
3½ Digit Meters
4½ Digit Meters
2-Wire Meters
Process Monitors
Application Boards
Application Notes

Quality Assurance

Quality and Reliability

To ensure that we produce the most reliable panel-meter products possible, DATEL's five-pronged Quality Assurance Program reaches into every aspect of new-product design, development, characterization, qualification and manufacturing.

Design for Reliability – Our multi-phased, new-product development process employs an approved components/vendors list, strict derating guidelines, worst-case analyses, extensive HALT, and FRACA (Failure Reporting Analysis and Corrective Action).

HALT – We use Highly Accelerated Life Testing extensively during new-product design and prototype phases. Exposing devices to gradually increasing stress levels reveals electrical and mechanical design weaknesses that could possibly result in future field failures.

Characterization and Qualification – Each new product has its electrical performance verified via a comprehensive characterization process. Its long-term reliability is confirmed by a rigorous qualification procedure that includes such strenuous tests as thermal shock and 500 hour life.

In-Line Process Controls and Screening – A combination of statistical sampling and 100% inspections keeps our assembly line under constant control. Parameters such as solder-paste thickness, component placement, cleanliness, etc. are statistically sampled, charted and fine tuned as necessary.

Rapid Response to Problems – Our outstanding corrective-action system immediately addresses any detected shortcomings in products or processes. Whenever our assembly, quality or engineering personnel detect a product/process problem, we immediately perform detailed failure analysis and, if necessary, institute corrective actions.

A Case History

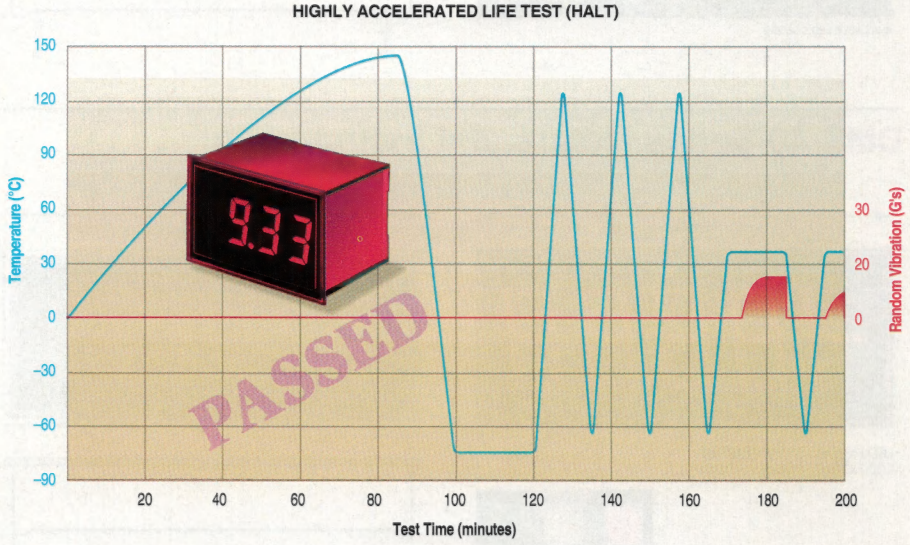
The QC Engineer who instituted DATEL's new *Design-for-Reliability Program* recently performed routine HALT (Highly Accelerated Life Testing) on a randomly selected digital meter . . . and the device "passed." Devices are not supposed to "pass" HALT. The intent of HALT is to "reveal latent defects or design weaknesses that may eventually cause field failures" by subjecting devices to progressively higher stress levels until something "breaks."

The Engineer decided to see how much it would take to make a second meter succumb. With the maximum applied input voltage, the meter (mounted in a metal panel using a DATEL bezel assembly) was subjected to the following: operating case-temperature extremes of +145°C and –75°C; nonoperating cold soak at –75°C (after which the meter turned on successfully); three temperature cycles (–65 to +125°C) at a transition rate of 30°C per minute; 15 minutes of 3-axis random longitudinal and rotational vibration at 10 to 15G's; a temperature spike down to –65°C; and then more vibration.

The intent of HALT is to "reveal latent defects or design weaknesses that may eventually cause field failures."

During the second vibration, the meter pulled away from the plastic bezel (which had melted during the +145°C temperature extreme), and one segment of one LED digit went blank. Upon troubleshooting, the Engineer discovered all meter electronics, including the drive circuit to the failed LED segment, were working fine. The failure was in the display itself. The Engineer's report gave the device a "conditional pass" pending failure analysis of the LED.

Now you know why we confidently specify our digital panel meters with an operating temperature range of 0 to +60°C and boast about their rugged, vibration and moisture-resistant, epoxy-encapsulated packages.



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3½ Digit Voltmeters

The physical size of a digital panel meter is limited only by the size of its display. DATEL's DMS-20 Series (subminiature packages) and DMS-30 Series (miniature packages) Digital Panel Voltmeters are fully functional, fully self-contained meters incorporating precision A/D converters, factory-trimmed reference circuits, and large easy-to-read LED or LCD displays in rugged, epoxy-encapsulated packages that are only slightly larger than the displays themselves.

Each meter's versatile, 12-pin, dual-in-line package offers component-like "plug-in" convenience for pc-board mounting as well as a built-in bezel for easy panel mounting.

LED meters are available in eleven different colors, including DATEL's exclusive low-power and high-intensity models. LCD meters are available with or without back-lighting. All operate from single supplies and are extremely reliable exhibiting levels of vibration, shock and moisture resistance not found in other meters.

Maximum versatility, ease-of-use, outstanding reliability and very affordable pricing make DMS-20/30 Meters the right choice for all your 3½ digit DPM applications.

1

Table of Contents

Selection Guides 1-2

3½ Digit, LED Display, Digital Panel Voltmeters

DMS-20PC Series Subminiature Package 1-3

DMS-30PC Series Miniature Package 1-9

3½ Digit, LCD Display, Digital Panel Voltmeters

DMS-20LCD Series Subminiature Package 1-15

DMS-30LCD Series Miniature Package 1-21

DMS-3019X Series Superior-Quality, Alternate Source for DP-650 Meters 1-27

Selection Guides

3½ Digit Meters, LED Displays

DMS-20PC Series

Page 1-3

LED Height: 0.37"/9.4mm
Package Size: 1.38" x 0.88" x 0.48"
35mm x 22mm x 12mm

Actual Size

Display Colors
- Amber
- Green
- Orange
- Red
- Super Red
- Low-Power Red
- Yellow

Input Ranges
- ±200mV
- ±2V
- ±20V
- ±200V

Display Functions
- DP Placement
- Enable
- Test/Hold
- Overrange

DMS-30PC Series

Page 1-9

LED Height: 0.56"/14.2mm
Package Size: 2.17" x 0.92" x 0.56"
55mm x 23mm x 14mm

Actual Size

Display Colors
- Amber
- Aqua
- Blue
- Green
- Low-Power Green
- Orange
- Low-Power Orange
- Red
- Super Red
- Low-Power Red
- Yellow

Input Ranges
- ±200mV
- ±2V
- ±20V
- ±200V

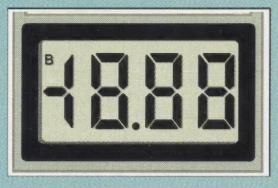
Display Functions
- DP Placement
- Test
- Overrange

3½ Digit Meters, LCD Displays

DMS-20LCD Series

Page 1-15

LCD Height: 0.37"/9.4mm
Package Size: 1.38" x 0.88" x 0.43"
35mm x 22mm x 11mm



Actual Size

Display Type
- Standard
- Backlit

Display Functions
- DP Placement
- Backlight
- Low Battery
- Overrange

Input Ranges
- ±200mV
- ±2V
- ±20V
- ±200V

Power Supply
- 5 Volt
- 9 Volt

DMS-30LCD and DMS-3019X Series

Pages 1-21 and 1-27

LCD Height: 0.4"/10.2mm
Package Size: 2.17" x 0.92" x 0.43"
55mm x 23mm x 11mm

Actual Size

Display Type
- Standard
- Backlit

Display Functions
- DP Placement
- Backlight
- Test
- Overrange

Input Ranges
- ±200mV
- ±2V
- ±20V
- ±200V

Power Supply
- 5 Volt
- 9 Volt

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Actual Size

DMS-20PC Series

3½ Digit, LED Display Low-Cost, Subminiature Digital Panel Voltmeters

1

Features

- Lowest-cost LED meters
- Subminiature size:
  1.38" x 0.88" x 0.48"
  35mm x 22mm x 12mm
- Large (0.37"/9.4mm) LED display
- Choice of 5 LED colors
- High-intensity or low-power (7mA) red LED's optional
- Epoxy-encapsulated, 12-pin DIP package with built-in color filter and bezel
- 4 differential input voltage ranges
- Factory calibrated, ±1 count accuracy
- Single +5V power supply
- User-selectable decimal point placement
- DISPLAY ENABLE function for "power-down" mode
- DISPLAY TEST and HOLD (optional) functions
- 0 to +60°C temperature range

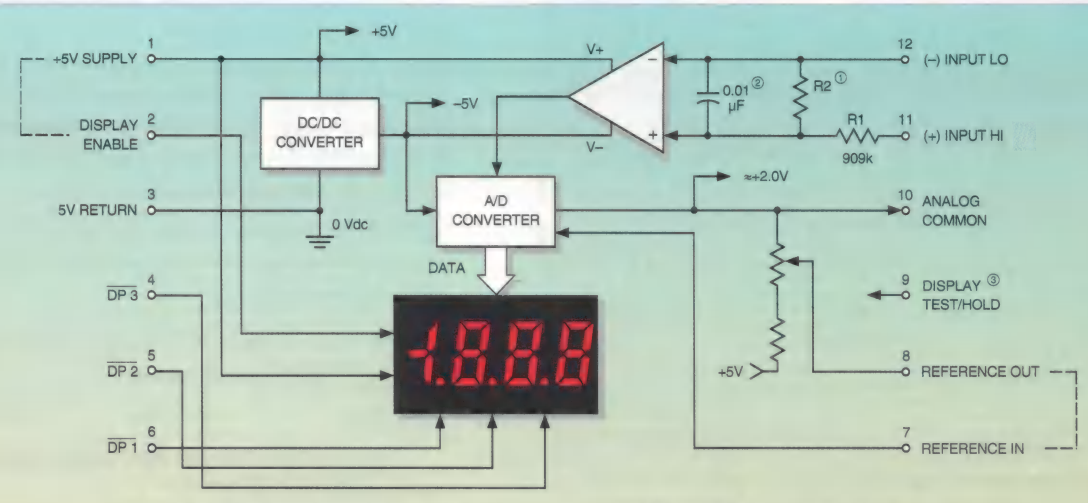
DMS-20PC Series, 3½ Digit, LED Display, Digital Panel Voltmeters combine a precision A/D converter; a factory-trimmed, highly stable, voltage reference; and a large (0.37"/9.4mm), easy-to-read LED display in a single package that is only slightly larger than the display itself. Displays are offered in either red, orange, amber, yellow or green colors. High-intensity and low-power (35mW total) red LED's are also optional.

These low-cost meters are fully self-contained and fully functional. Their subminiature (1.38" x 0.88" x 0.48"), epoxy-encapsulated cases incorporate built-in color filters and bezels; are moisture and vibration proof; and function well in the harshest environments. Their 12-pin, dual-in-line configuration offers component-like, plug-in convenience and maximum versatility. Operating temperature range is 0 to +60°C.

The meters come with one of four, differential, input voltage ranges: ±200mV, ±2V ±20V or ±200V. Input impedance is a minimum 800kΩ. CMRR is typically 86dB (dc to 60Hz), and CMV is ±2V. Input overvoltage protection (on the non-inverting input) is ±250V. Devices are fully calibrated at the factory to an accuracy of ±1 count (±0.05% of full scale range) and never require calibration or adjustment.

A DISPLAY ENABLE function permits the display to be disabled for "power-down" operation. All models have a DISPLAY TEST function. Standard red LED models offer an optional DISPLAY HOLD function.

Small size, low cost and adjustment-free reliability make the DMS-20PC Series the best choice for all your 3½ digit, LED, DPM applications.



① R2 is not used on ±200mV (-0) models or ±2V (-1) models.
R2 = 100k on ±20V (-2) models and 9.1k on ±200V (-3) models.

② Only used on ±200mV (-0) and ±2V (-1) models.

③ Pin 9 is DISPLAY TEST on all but eight models. On those models (-H option), it is DISPLAY HOLD.

Figure 1. DMS-20PC Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V using the single-ended input circuit, unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range:				
DMS-20PC-0	--	±200	--	mV
DMS-20PC-1	--	±2	--	Volts
DMS-20PC-2	--	±20	--	Volts
DMS-20PC-3	--	±200	--	Volts
Input Impedance:				
DMS-20PC-0, -1	100	1000	--	MΩ
DMS-20PC-2, -3	0.8	1	--	MΩ
Overvoltage Protection ①	--	--	±250	Volts
Common Mode Voltage Range	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ② ③				
Decimal Point Placement (Pins 4-6)	Tie to pin 3 to activate			
Display Test (Pin 9)	Tie to pin 1 to activate all segments			
Display Hold (Pin 9) ③	Tie to pin 1 to hold last reading			
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (3 minute warm-up):				
DMS-20PC-0 (V_{IN} = +0.19V)	--	±1	±3	Counts
DMS-20PC-1 (V_{IN} = +1.9V)	--	±1	±3	Counts
DMS-20PC-2 (V_{IN} = +19V)	--	±2	±3	Counts
DMS-20PC-3 (V_{IN} = +190V)	--	±2	±3	Counts
Zero Reading (V_{IN} = 0 Volts)	"–001"	"000"	"001"	
Temperature Drift (0 to +60°C)	--	±0.2	±0.4	Cnts/°C
Power Supply Requirements				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
DMS-20PC-X-RS	--	+60	+90	mA
DMS-20PC-X-RL	--	+7	+12	mA
DMS-20PC-X-AS	--	+90	+120	mA
DMS-20PC-X-GS	--	+90	+120	mA
DMS-20PC-X-OS	--	+90	+120	mA
DMS-20PC-X-YS	--	+90	+120	mA
DMS-20PC-X-RS-H	--	+60	+90	mA
DMS-20PC-X-GS-H	--	+90	+120	mA
DMS-20PC-X-RH	--	+60	+90	mA
Display				
Display Type and Size	3½ Digit LED, 0.37"/9.4mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–1___" for negative V_{IN} "1___" for positive V_{IN}			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–40	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.4 ounces (11 grams)			

① Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.

② See Technical Notes.

③ The DISPLAY HOLD function is optional on standard red and green LED models only. See Ordering Information.

Ordering Information

DMS-20PC - 1 - RS

Input Range:
0 = ±200mV
1 = ±2V
2 = ±20V
3 = ±200V

Leave blank for standard models.
Add **-H** for DISPLAY HOLD option (available on standard red and green LED models only).

LED Color:
AS = Standard Amber
GS = Standard Green
OS = Standard Orange
RS = Standard Red
YS = Standard Yellow
RH = High-Intensity Red
RL = Low-Power Red

Accessories:

DMS-20-CP	Panel cutout punch
DMS-BZL3	DMS-20 bezel assembly
DMS-BZL4	DMS-20 bezel assembly with sealing gasket
DMS-EB2	Application/evaluation board with standard MOLEX connector, decimal point solder pads and attenuation resistor pads.

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **REFERENCE OUTPUT (Pin 8) and INPUT (Pin 7):** Pin 8 is a precision reference actively trimmed at the factory. In normal operation, pin 8 must be tied to pin 7 to achieve all listed accuracy and drift specifications.
2. **ANALOG COMMON (Pin 10):** This pin is connected to an internal, low-noise, "relative" ground. It is used in certain differential and "floating" measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. **Pin 10 should not be connected to pin 3 (5V RETURN) or to your system's analog ground.**
3. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP3) are active low functions. Select the appropriate decimal point by tying the appropriate pin (pin 4, 5 or 6) to pin 3 (5V RETURN). Unused decimal point location pins should be left open.

   Hard wiring is preferable, however, you can use logic gates to exercise dynamic control over the location of the decimal point if the following drive conditions are met:

Model	Applied "0" Voltage	Load Current*
DMS-20PC-X-RL	+0.05V max.	0.7mA max.
All Others	+0.4V max.	6mA max.

* The driving gates must be able to sink this much current (I_{OL}) with a logic "0" output.

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4. **DISPLAY TEST/HOLD (Pin 9) Function:** Pin 9 is a dual-function pin. On all standard models (without "-H" suffix), tying pin 9 to pin 1 (+5V SUPPLY) activates the meter's DISPLAY TEST feature. All display segments, except the decimal points, will be illuminated. The display will show "1888" ("–1888" if a negative input signal is present). **Do not leave the meter in the test mode for more than 10 seconds as this will cause the meter's operating temperature to rise and possibly affect its performance.** Pin 9 must be left open when the test function is not being used.

   On models with the "-H" suffix (DMS-20PC-1-RS-H for example), pin 9 serves as a DISPLAY HOLD control pin. Tying pin 9 to +5V SUPPLY (pin 1) on these models will hold or "freeze" the current display reading indefinitely. Pin 9 must also be left open when the hold function is not being used. After disabling DISPLAY HOLD, allow the meter a full 10 seconds to resume normal calibrated operation before holding a new reading.

   The DISPLAY TEST or DISPLAY HOLD pin should normally be connected, via a selector switch, to pin 1 (+5V SUPPLY). If automatic, logic-controlled operation is desired, only PNP or MOSFET transistors should be used. The base or gate of these transistors should be driven sufficiently hard to bring pin 9 within 0.05V of +5V SUPPLY.

5. **DISPLAY ENABLE (Pin 2) Function:** On all models, tying pin 2 to pin 1 (+5V SUPPLY) applies full power to the LED display. This is the normal mode of operating the meter. Leaving DISPLAY ENABLE open (no connection), only turns off the LED display. The meter's analog-to-digital converter continues to sample the input signal. Total current consumption with the display off is approximately 400µA (0.4mA). This is a very useful feature if the meter is used in battery-powered equipment.

   With the exception of the low-power red LED models (DMS-20PC-X-RL), a regulated voltage lower than +5V SUPPLY can be used to dim the display intensity. Display intensity control is best performed with the high brightness, red LED, DMS-20PC-X-RH model. All low-power red LED models must have DISPLAY ENABLE tied directly to pin 1 (+5V SUPPLY). Voltages applied to DISPLAY ENABLE must never be greater than +5V SUPPLY.

6. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±50 counts (±2.5%) range of adjustment. Since these devices essentially have no zero/offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals. The circuit shown in Figure 10 provides ±10% range of adjustment.

7. **Soldering Methods:** All models in the DMS-20PC Series easily withstand most common wave soldering operations. We recommend, however, that you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.

8. **Suggested Mating Connectors:**

   Panel mounted:

Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)

   Board mounted:

Socket	DATEL P/N 39-2359625

Applications

DMS-20PC meters are highly versatile devices that can be used in hundreds of applications. The application circuits chosen for this section are ones that have historically received many inquiries.

The schematic in Figure 1 shows that the meter's high-impedance input consists of an op amp powered from a ±5Vdc power supply (the –5V is internally generated). One can easily see why input signals applied to (–) INPUT LO and (+) INPUT HI have to be kept within the power supply rails of ±5V. Also note that only pin 11 has a current-limiting 909kΩ series resistor. High input voltages that have a common ground with pin 3 (5V RETURN) should only be applied to pin 11 ((+) INPUT HI) and never to pin 12. In these high-voltage cases, pin 12 should always be tied to pin 3 (5V RETURN).

The schematic also shows that pin 3 is the meter's zero-volt reference point — regardless of the type of power or signal source used. This is an important point to keep in mind when a digital or analog multimeter is used to make system measurements. The multimeter's negative lead (usually the black one) must be connected to pin 3 (5V RETURN).

1. **Single-Ended Input Configurations:** True single-ended measurements can be made with any DMS-20PC meter. The circuit of Figure 2 avoids problems normally associated with ground-loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12).

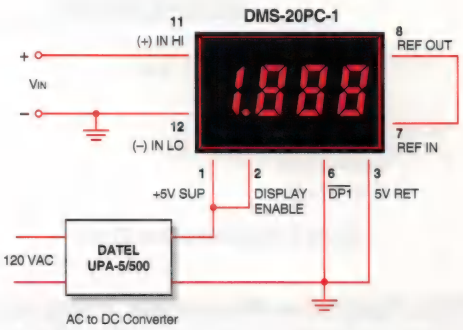

Figure 2. Single-Ended Input Configuration

Applications

2. **Differential Input Configurations:** Differential measurements can be made with all DMS-20PC meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V-powered meters.

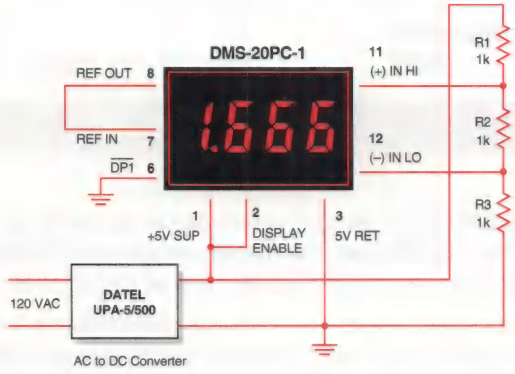

Figure 3. Differential Input Configuration

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal-film resistors with absolute TCR's less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

$$50k\Omega < R1 + R2 < 10M\Omega$$

$$\frac{R2}{R1 + R2} \times V_{IN} = Reading$$

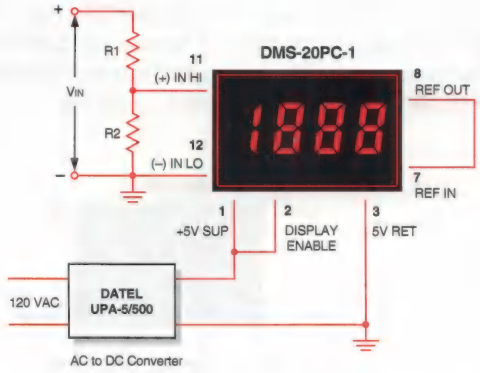

Figure 4. Input Attenuation Circuit

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6. Connecting pin 10 (ANALOG COMMON) or pin 3 (5V RETURN) to (–) INPUT LO (pin 12) provides the reference point for the meter's input.

A "floating" input is a signal that has no galvanic connection to the meter's power supply. In the figures below, the 1.5V battery illustrates a true floating input.

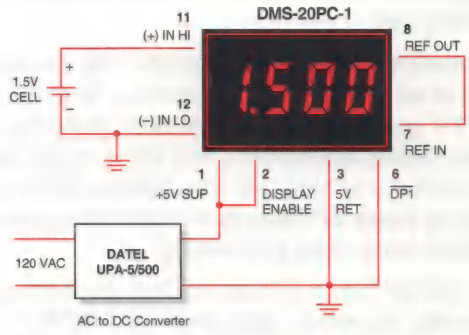

Figure 5. Floating Input Measurements

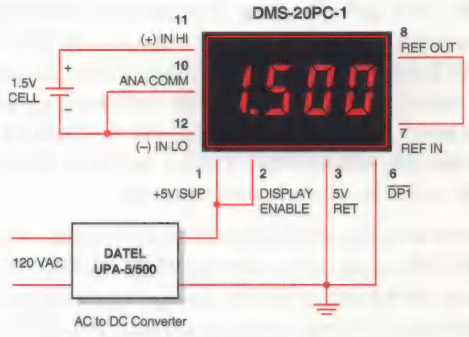

Figure 6. Floating Input Measurements (Alternate Configuration)

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-20PC meters have such high input impedance, a simple shunt resistor across the meter's input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a function of the scaling requirements of the particular application and can be calculated using the following equation:

$$R_{Shunt} = R1 = V_{Fsr} / I_{Fsr}$$

Where: V_{Fsr} = Full scale reading (in Volts)

I_{Fsr} = Relative full scale current (in Amps)

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Applications

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired display reading of "1000" (with an input of 20mA), V_{Fsr} = 1.000 Volts

$$R_{Shunt} = 1.000V/(0.020 - 0.004)A$$

$$R_{Shunt} = 1.000V/0.016A = 62.5 \text{ Ohms}$$

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "1000". For different full scale readings, alter the value of R_{Shunt} accordingly.

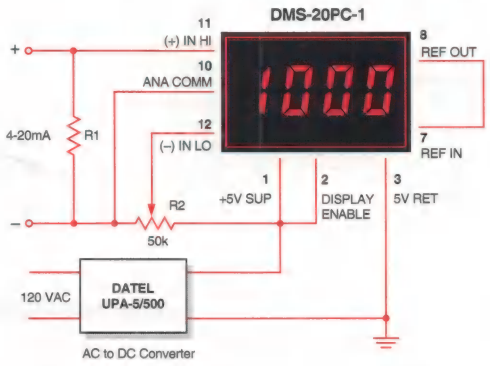


Figure 7. 4-to-20mA Current Loop Operation

6. **Power Supply Monitoring:** One of the most common digital panel meter applications involves monitoring the output voltage of the system power supply — often this supply also powers the meter itself. The low-power, red LED DMS-20PC-2-RL can be configured to allow power supply monitoring over the range of 4.5-18Vdc. The circuit in Figure 8 uses a low-drop-out, three-terminal regulator (LM-2931Z-5, available from National Semiconductor) to provide regulated 5V-power to the meter.

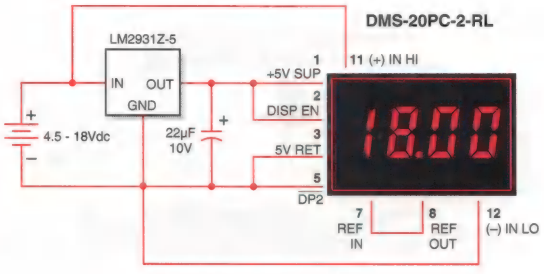


Figure 8. 4.5V-18V Power Supply Monitor

The LM-2931 was chosen because it has the following on-chip protection features: reverse polarity, short circuit and thermal runaway. When using other, higher-power, DMS-20PC models with three-terminal regulators, be sure to consult the regulator manufacturer's data sheet to ensure the regulator is being utilized safely and correctly.

7. **Digital Ammeter:** Digital ammeters are finding ever-increasing usage because analog-style ammeters (moving-vane types) now cost roughly the same as their digital counterparts. Additionally, analog ammeters are not nearly as rugged as modern digital panel voltmeters. Figure 9 illustrates a typical ammeter application. The circuit uses a ±200mV input meter — the preferred range for most ammeters — to measure the voltage developed across a 0.1Ω current shunt. The circuit shown represents a basic ammeter connection diagram. A detailed application note describing digital dc ammeters is included in DATEL's new Digital Panel Meter Databook.

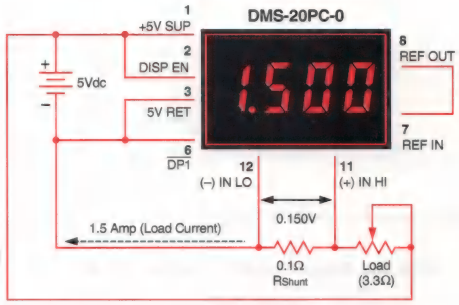


Figure 9. DC Ammeter Circuit

8. **External Gain Adjustment:** Connect REFERENCE OUT (pin 8) to REFERENCE IN (pin 7) for normal, factory calibrated, operation. Use the circuit shown in Figure 10 for applications needing external gain adjustment. Calibration is performed with a precise, near-full-scale, input voltage.

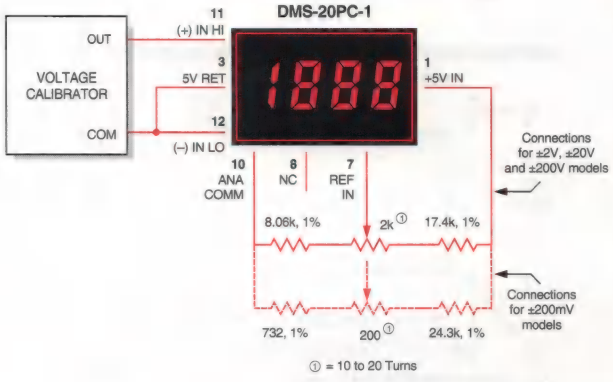
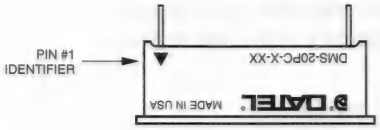


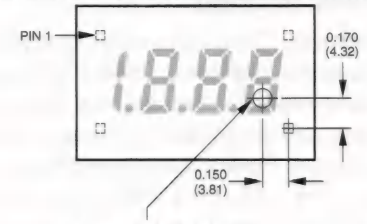
Figure 10. External Gain Adjustment

Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)

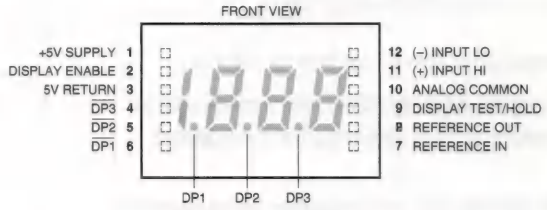


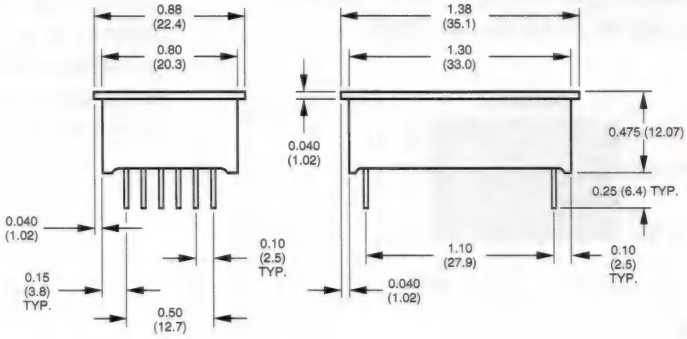
CALIBRATION POTENTIOMETER HOLE LOCATION



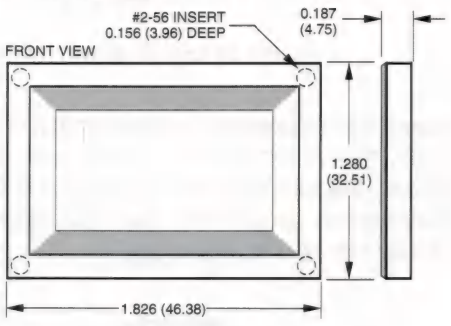
0.125 (3.175) DIAMETER
(USE ONLY WHEN
PC BOARD MOUNTING)

FRONT VIEW

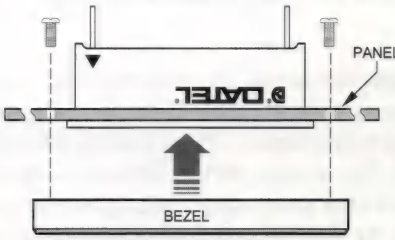




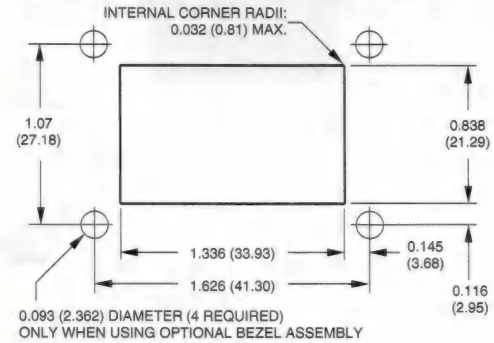
OPTIONAL BEZEL (DMS-BZL3 and DMS-BZL4)



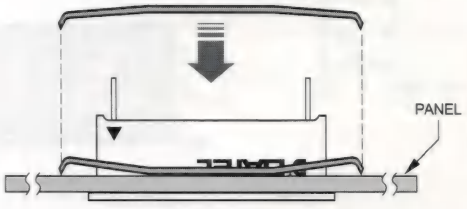
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



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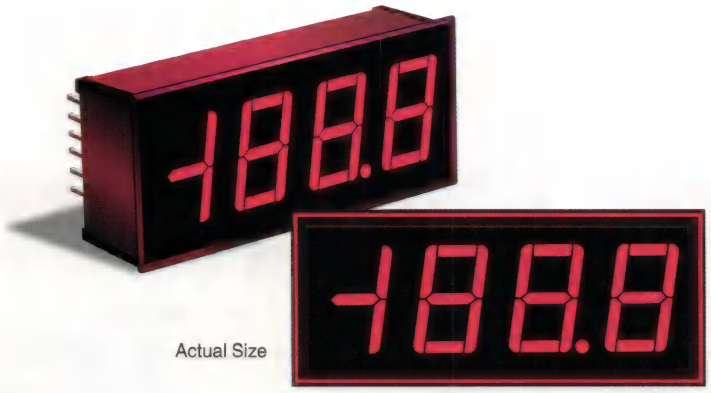

DMS-30PC Series

3½ Digit, LED Display Low-Power, Miniature Digital Panel Voltmeters

Features

- Large (0.56"/14.2mm) LED display
- 7 LED colors
- Low-power LED's optional
- Epoxy-encapsulated, 12-pin DIP with built-in color filter and bezel
- Miniature size:
  2.17" x 0.92" x 0.56"
  55mm x 23mm x 14mm
- Panel or pc-board mountable
- 4 differential input voltage ranges
- Auto-calibration, ±1 count accuracy
- User-selectable decimal point placement
- Single +5V supply (60mW for low-power models)
- 0 to +60°C temperature range
- Numerous "plug-on" application boards
- Low cost

The DMS-30PC Series is a broad line of self-contained, fully operational, 3½ digit voltmeters with large, easy-to-read LED displays. The 0.56"(14.2mm) high LED's are available in a wide variety of colors including red, orange, amber, yellow, green, aqua and blue. A high-intensity version of the red display is optional as are low-power versions of the red, orange and green displays.

The small size (2.17" x 0.92" x 0.56") of DMS-30PC meters is achieved by integrating their display, display drivers, reference circuit, and A/D converter into in a single, epoxy-encapsulated assembly. The device's 12-pin, component-like, DIP package is both vibration and moisture proof. Each package incorporates a built-in color filter and bezel and is easily mounted in either panels or pc cards.

These meters are available in four differential input voltage ranges (±200mV, ±2V, ±20V and ±200V). Input impedance is 1,000 megohms for the ±200mV and ±2V inputs and 1 megohm for the ±20V and ±200V inputs. CMRR for all devices is 86dB, and inputs are overvoltage protected to ±250V.

Each meter incorporates an extremely stable, double-regulated reference and is fully calibrated prior to potting. We guarantee outstanding initial accuracy (±1 count) and excellent stability (±0.15 counts/°C). All models operate from a single +5V supply, and the low-power models draw as little as 10mA (50mW total power). A DISPLAY TEST function is standard on each device.

For popular applications (4-to-20mA, rms-to-dc conversion, ac line power, J and K thermocouples, etc.), the DMS-30PC Series includes a complete line of optional "plug-on" application boards that conveniently convert your meter into an application-specific instrument.

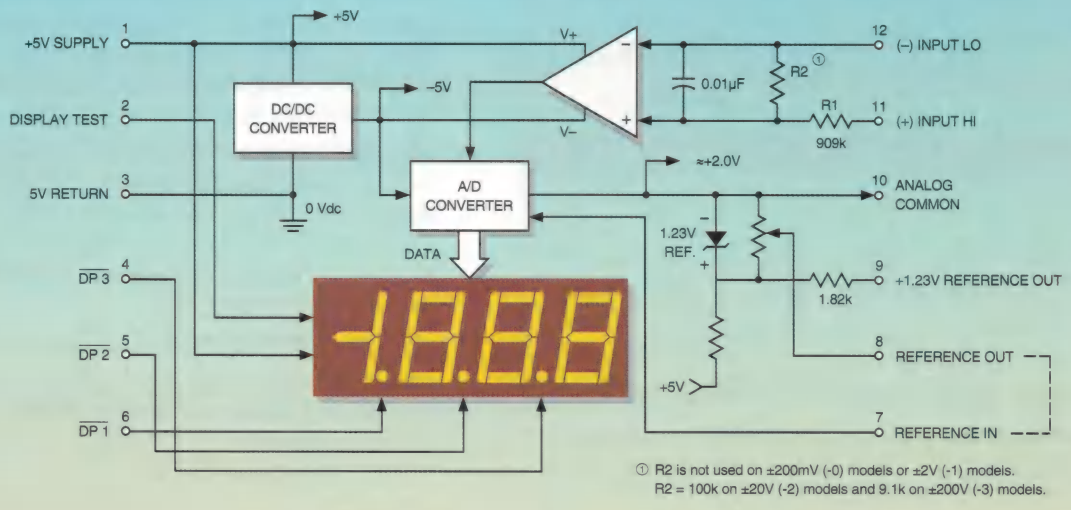

Figure 1. DMS-30PC Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V using the single-ended input circuit, unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range:				
DMS-30PC-0	--	±200	--	mV
DMS-30PC-1	--	±2	--	Volts
DMS-30PC-2	--	±20	--	Volts
DMS-30PC-3	--	±200	--	Volts
Input Impedance:				
DMS-30PC-0, -1	100	1000	--	MΩ
DMS-30PC-2, -3	0.8	1	--	MΩ
Overvoltage Protection ①	--	--	±250	Volts
Common Mode Voltage Range	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ②				
Decimal Point Placement (Pins 4-6)	Tie to pin 3 to activate			
Display Test (Pin 2)	Tie to +5V to activate all segments			
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (3 minute warm-up):				
DMS-30PC-0 (V_{IN} = +0.19V)	--	±1	±2	Counts
DMS-30PC-1 (V_{IN} = +1.9V)	--	±1	±2	Counts
DMS-30PC-2 (V_{IN} = +19V)	--	±2	±3	Counts
DMS-30PC-3 (V_{IN} = +190V)	--	±2	±3	Counts
Zero Reading (V_{IN} = 0 Volts)	"–001"	"000"	"001"	
Temperature Drift (0 to +60°C)	--	±0.15	±0.3	Cnts/°C
+1.23V Reference Output (Pin 9) ②	+1.20	+1.23	+1.25	Volts
Power Supply Requirements				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
Standard Models:				
Blue display	--	+400	+550	mA
All others	--	+150	+225	mA
Low-Power Models:				
Red display	--	+12	+17	mA
Green or orange display	--	+60	+100	mA
Display				
Display Type and Size	3½ Digit LED, 0.56"/14.2mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–1___" for negative V_{IN} "1___" for positive V_{IN}			
Physical/Environmental				
Operating Temperature:				
Blue display models	0	--	+50	°C
All other models	0	--	+60	°C
Storage Temperature	–40	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.75 ounces (21 grams)			

① Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.

② See Technical Notes.

Ordering Information

DMS-30PC - 1 - RS

Input Range:
- **0** = ±200mV
- **1** = ±2V
- **2** = ±20V
- **3** = ±200V Available on the following models only: -GS (Standard Green), -RS (Standard Red), -RL (Low-Power Red)

LED Color:
- **AS** = Standard Amber
- **BS** = Standard Blue
- **GS** = Standard Green
- **OS** = Standard Orange
- **QS** = Standard Aqua
- **RS** = Standard Red
- **YS** = Standard Yellow
- **RH** = High-Intensity Red
- **GL** = Low-Power Green
- **OL** = Low-Power Orange
- **RL** = Low-Power Red

Accessories:

DMS-30-CP	Panel cutout punch
DMS-BZL1	DMS-30 bezel assembly
DMS-BZL2	DMS-30 bezel assembly with sealing gasket
RN-DMS	Gain/offset potentiometer kit for DMS-EB, DMS-EB-AC/DC and DMS-EB-DC/DC

Add-On Application Boards:

DMS-EB	Multi-purpose (gain/offset, 4-20mA, etc.)
DMS-EB-HTB	High-accuracy temperature probe sensing for ±200mV models
DMS-EB-DC/DC	Provides isolated +5V power
DMS-EB-TCJ	J-type thermocouple inputs for ±2V models
DMS-EB-TCK	K-type thermocouple inputs for ±2V models
DMS-EB-RMS	For true rms measurements of ac voltages
DMS-EB-AC/DC	For ac line-powered applications
DMS-EB-LP	For 4-to-20mA loop-powered applications

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **+1.23V REFERENCE OUTPUT (Pin 9):** This pin is the output of the meter's precision +1.23V internal reference, and it is referenced to ANALOG COMMON (pin 10) which sits at a potential of approximately +2V. This output should be buffered if used to drive external loads since sourcing more than 15µA from pin 9 can affect both the initial accuracy and temperature drift of the meter.
2. **ANALOG COMMON (Pin 10):** This pin is connected to an internal, low-noise, "relative" ground. It is used in certain differential and "floating" measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. **Pin 10 should not be connected to pin 3 (5V RETURN) or to your system's analog ground.**
3. **REFERENCE OUTPUT (Pin 8) and INPUT (Pin 7):** Pin 8 is a precision reference actively trimmed at the factory. In normal operation, pin 8 must be tied to pin 7 to achieve all listed accuracy and drift specifications.

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4. **DISPLAY TEST (Pin 2):** Connecting pin 2 to +5V SUPPLY (pin 1) will activate all LED segments, except the decimal points, and the display will read "1888" regardless of the actual applied input. If a negative input is applied, DISPLAY TEST will also activate the minus sign. **To protect the LED's, the display should not be left in the "test" mode for more than 10 seconds.**

5. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP3) are active low functions. Select the desired decimal point by tying the appropriate pin (pin 4, 5 or 6) to pin 3 (5V RETURN). Unused decimal point location pins should be left open.

   Hard wiring is preferable, however, you can use logic gates to exercise dynamic control over the location of the decimal point if the following drive conditions are met:

Model	Applied "0" Voltage	Load Current*
DMS-30PC-X-RL	+0.05V max.	0.7mA max.
DMS-30PC-X-BS	+0.3V max.	18mA max.
All Others	+0.4V max.	6mA max.

   * The driving gates must be able to sink this much current (I_{OL}) with a logic "0" output.

6. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±50 counts (±2.5%) of adjustment range. Since these devices essentially have no zero/offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals. The circuit shown in Figure 10 provides ±10% range of adjustment.

7. **Soldering Methods:** All models in the DMS-30PC Series easily withstand most common wave soldering operations. We recommend, however, that you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.

8. **Suggested Mating Connectors:**

   Panel mounted:

Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)

   Board mounted:

Socket	DATEL P/N 39-2359625

Applications

DMS-30PC meters are highly versatile devices that can be used in hundreds of applications. The application circuits chosen for this section have historically received many inquiries. Every attempt has been made to ensure technical accuracy, and all of the following circuits have been prototyped and tested to ensure functionality. Please keep in mind, however, that real-world applications are seldom as straightforward as the approaches presented here. Most applications have many more components — and many more connections — than the illustrations show.

The simplified schematic shown in Figure 1 can be very useful when debugging a malfunctioning panel meter circuit, particularly if the user has some knowledge of operational amplifiers (op amps). The meter's high-impedance input consists of an op amp powered from a ±5Vdc power supply (the –5V is internally generated). Knowing this, one can easily see why input signals applied to (–) INPUT LO and (+) INPUT HI have to be kept within the power supply rails of ±5V. Also note that only pin 11 has a current-limiting 909kΩ series resistor. High input voltages that have a common ground with pin 3 (5V RETURN) should only be applied to pin 11 ((+) INPUT HI) and never to pin 12. In these high-voltage cases, pin 12 should always be tied to pin 3 (5V RETURN).

One of the simplified schematic's noteworthy features is that it shows internal voltage values. It also shows that pin 3 is the meter's zero-volt reference point — regardless of the type of power or signal source used. This is an important point to keep in mind when a digital or analog multimeter is used to make system measurements. The multimeter's negative lead (usually the black one) must be connected to pin 3 (5V RETURN).

1. **Single-Ended Input Configurations:** True single-ended measurements can be made with any DMS-30PC meter. The circuit of Figure 2 avoids problems normally associated with ground-loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12). This will ensure that large LED currents will not flow in the wiring that connects V_{IN} to (–) INPUT LO (pin 12). Ground-loop currents can cause unstable readings.

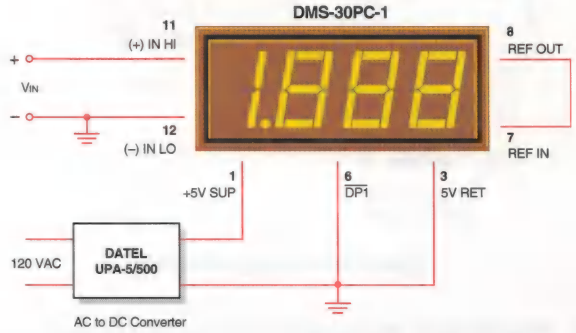

Figure 2. Single-Ended Input Configuration

Applications

2. **Differential Input Configurations:** Differential measurements can be made with all DMS-30PC meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V-powered meters.

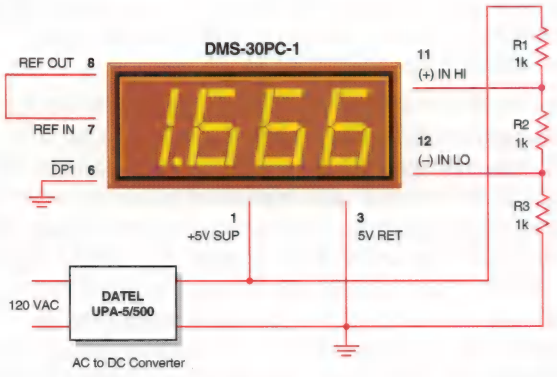

Figure 3. Differential Input Configuration

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal-film resistors with absolute TCR's less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

$$50k\Omega < R1 + R2 < 10M\Omega$$

$$\frac{R2}{R1 + R2} \times V_{IN} = \text{Reading}$$

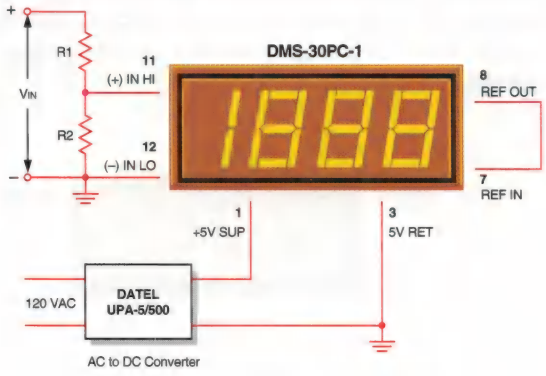

Figure 4. Input Attenuation Circuit

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6.

Connecting pin 10 (ANALOG COMMON) or pin 3 (5V RETURN) to (–) INPUT LO (pin 12) provides the reference point for the meter's input.

A "floating" input is a signal that has no galvanic connection to the meter's power supply. In the figures below, the 1.5V battery illustrates a true floating input.

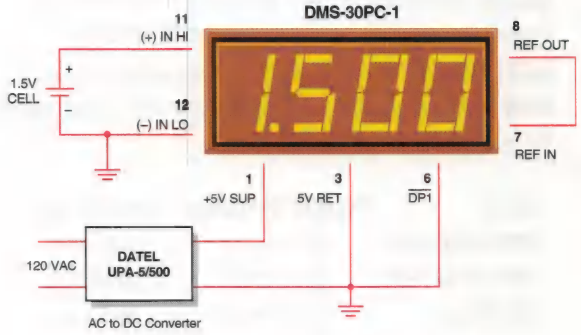

Figure 5. Floating Input Measurements

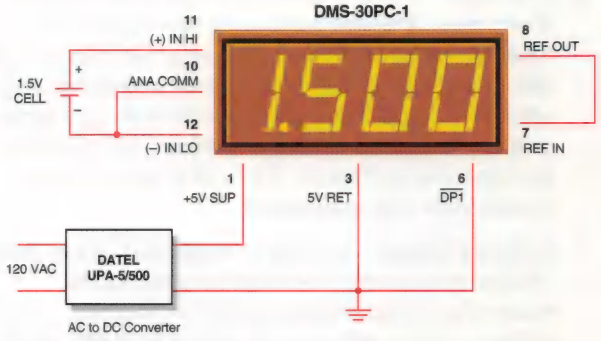

Figure 6. Floating Input Measurements (Alternate Configuration)

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-30PC meters have such high input impedance, a simple shunt resistor across the meter's input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a function of the scaling requirements of the particular application and can be calculated using the following equation:

$$R_{Shunt} = R1 = V_{Fsr} / I_{Fsr}$$

Where: V_{Fsr} = Full scale reading (in Volts)

I_{Fsr} = Relative full scale current (in Amps)

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Applications

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired display reading of "1000" (with an input of 20mA), V_{Fsr} = 1.000 Volts

$$R_{Shunt} = 1.000V/(0.020 - 0.004)A$$

$$R_{Shunt} = 1.000V/0.016A = 62.5 \text{ Ohms}$$

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "1000". For different full scale readings, alter the value of R_{Shunt} accordingly.

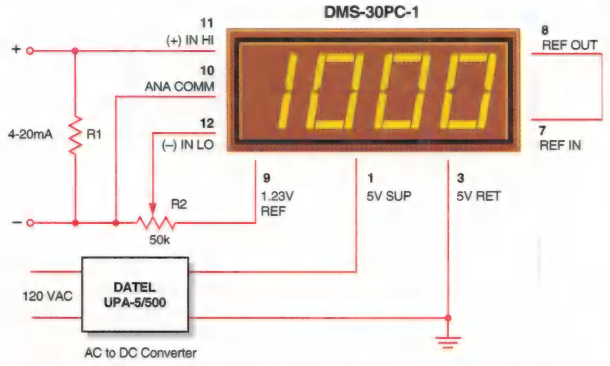


Figure 7. 4-to-20mA Current Loop Operation

6. **Power Supply Monitoring:** One of the most common digital panel meter applications involves monitoring the output voltage of the system power supply — often this supply also powers the meter itself. The low-power, red LED DMS-30PC-2-RL can be configured to allow power supply monitoring over the range of 4.5-18Vdc. The circuit in Figure 8 uses a low-drop-out, three-terminal regulator (LM-2931Z-5, available from National Semiconductor) to provide regulated 5V power to the meter. The LM-2931 was chosen because it has the following on-chip protection features: reverse polarity, short circuit and thermal run-away. When using other, higher-power, DMS-30PC models with three-terminal regulators, be sure to consult the regulator manufacturer's data sheet to ensure the regulator is being utilized safely and correctly.

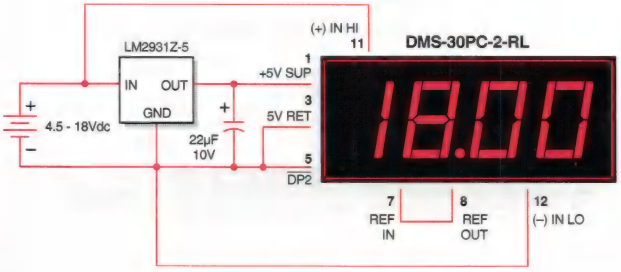


Figure 8. 4.5-18V Power Supply Monitor

7. **Digital Ammeter:** Digital ammeters are finding ever-increasing usage because analog-style ammeters (moving-vane types) now cost roughly the same as their digital counterparts. Additionally, analog ammeters are not nearly as rugged as modern digital panel voltmeters. Figure 9 illustrates a typical ammeter application. The circuit uses a ±200mV input meter — the preferred range for most ammeters — to measure the voltage developed across a 0.1Ω current shunt. The circuit shown represents a basic ammeter connection diagram. A detailed application note describing digital dc ammeters is included in DATEL's new Digital Panel Meter Databook.

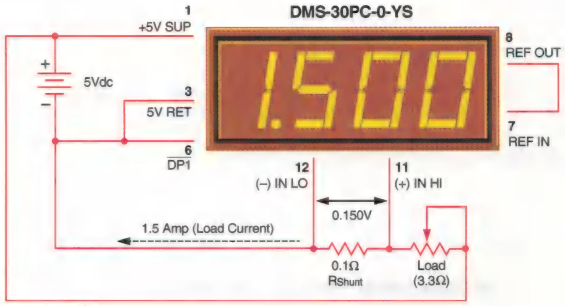


Figure 9. Basic DC Ammeter Circuit

8. **External Gain Adjustment:** Connect REFERENCE OUT (pin 8) to REFERENCE IN (pin 7) for normal, factory calibrated, operation. Use the +1.23V REFERENCE OUT (pin 9) for applications needing external gain adjustment. Figure 10 shows the wiring configuration for each model. Calibration is performed with a precise, near-full-scale, input voltage.

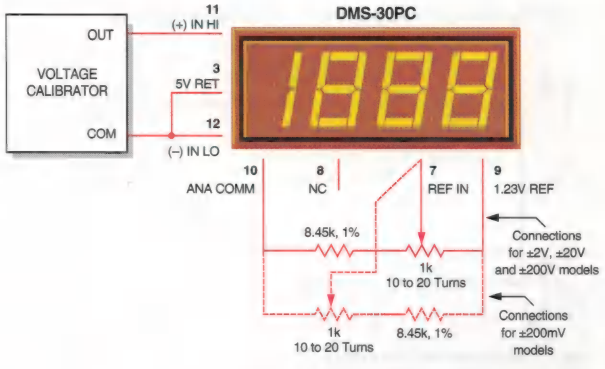
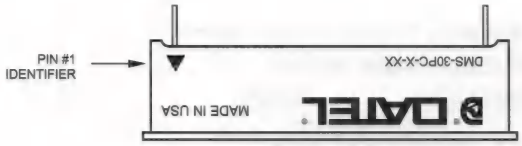
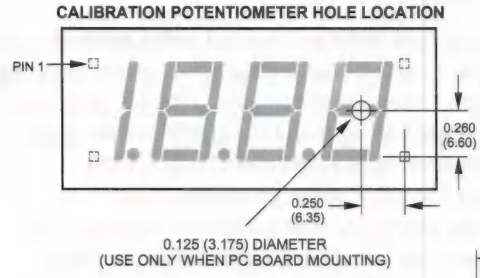


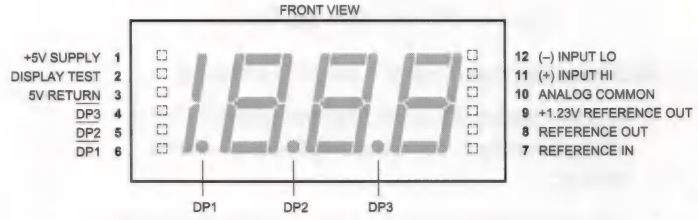
Figure 10. External Gain Adjustment

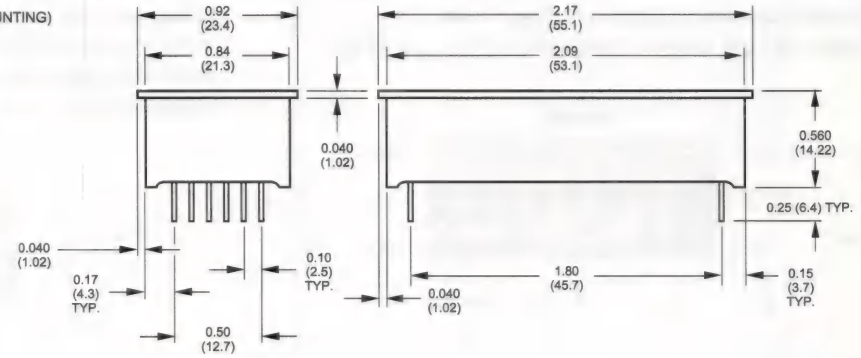
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)

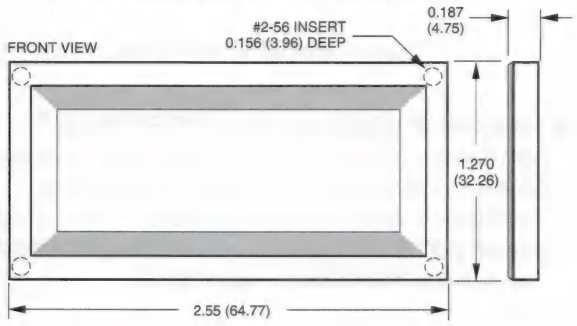




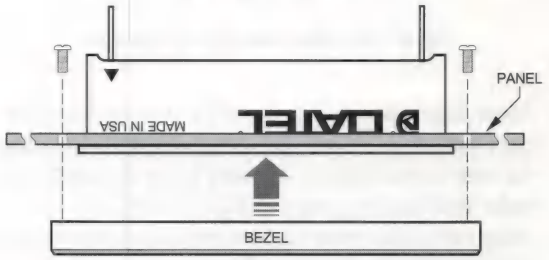




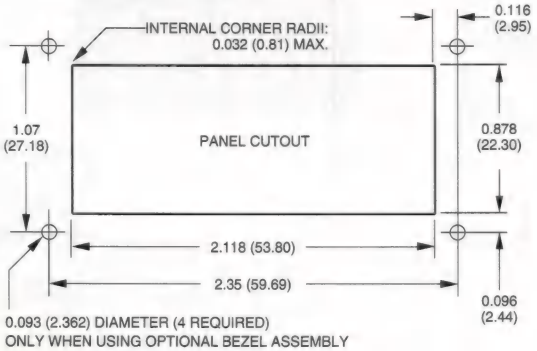
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION

DS-0258 Rev. D

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Actual Size

DMS-20LCD Series

3½ Digit, LCD Display Low-Cost, Subminiature Digital Panel Voltmeters

Features

- Lowest cost
- Lowest power, 2mW
- Subminiature size:
  1.38" x 0.88" x 0.43"
  35mm x 22mm x 11mm
- Large (0.37"/9.4mm), enhanced-contrast LCD display
- Backlit displays optional
- Epoxy-encapsulated, 12-pin DIP
- Panel or pc-board mountable
- 4 differential input voltage ranges
- High accuracy, ±1 count (±0.05%)
- Single +5V supply or 9V battery
- Low-battery annunciator
- User-selectable decimal point placement
- 0 to +60°C temperature range

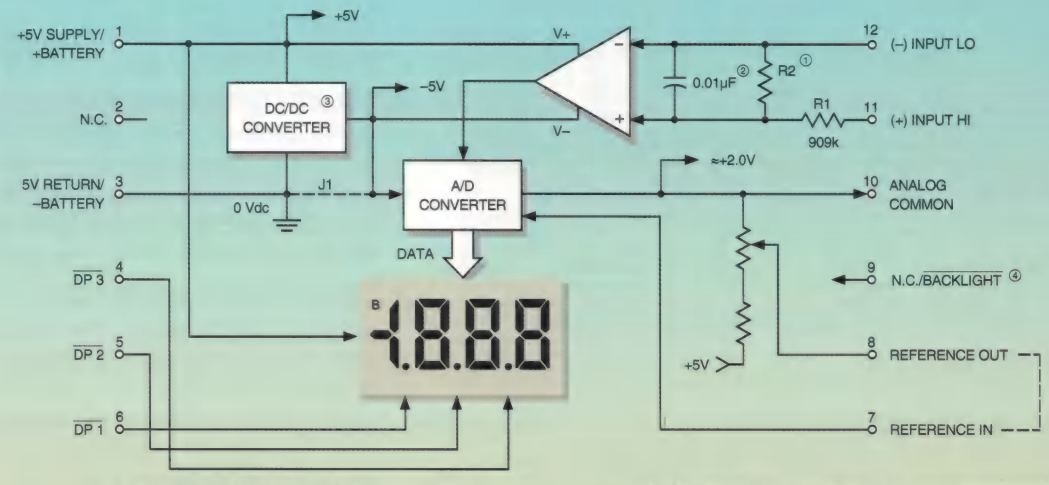
DMS-20LCD Series, 3½ Digit, LCD Display, Digital Voltmeters represent the ultimate combination of low price, low power, small size and high performance in digital meters. Epoxy encapsulated in a subminiature (1.38" x 0.88" x 0.43"), 12-pin DIP package, these completely self-contained, fully operational meters offer a combination of ruggedness, long-term reliability and component-like ease-of-use simply not available in any other meters.

Incorporating a precision reference and a factory-calibrated, autozeroing A/D converter, DMS-20LCD meters are extremely accurate (±1 count) and are only slightly larger than their 0.37"/9.4mm, enhanced-contrast, LCD displays. All models incorporate a built-in bezel and are easily mounted in either panels or pc boards. Both backlit and non-backlit versions are available.

DMS-20LCD meters have 4 differential input voltage ranges (±200mV, ±2V, ±20V and ±200V) and a user-friendly input structure. Input impedance is a minimum 800kΩ. CMRR is typically 86dB with a CMV of ±2V. Non-inverting inputs are overvoltage protected to ±100V (±250V for the ±200V input model).

All DMS-20LCD meters operate from a single +5V supply (drawing 400µA) or a single +9V supply/battery (drawing 230µA). All models have a low-battery ("B") annunciator and feature autopolarity changeover and overrange indication.

Also available is an application/evaluation board (DMS-EB2) that plugs directly onto the back of any DMS-20LCD allowing direct inputs for common applications such as 4-20mA inputs, zero/gain adjust, decimal point location, and input voltage dividing.



① R2 is not used on ±200mV (-0) models or ±2V (-1) models. R2 = 100k on ±20V (-2) models and 9.1k on ±200V (-3) models.
② Only used on ±200mV (-0) and ±2V (-1) models.
③ DC/DC converter is not used on 9V-powered models, J1 is connected.
④ Used on backlit models only. N.C. for non-backlit models.

Figure 1. DMS-20LCD Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V (using the single-ended input circuit) or +9V (using the differential input circuit), unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range:				
DMS-20LCD-0	--	±200	--	mV
DMS-20LCD-1	--	±2	--	Volts
DMS-20LCD-2	--	±20	--	Volts
DMS-20LCD-3	--	±200	--	Volts
Input Impedance:				
DMS-20LCD-0, -1	100	1000	--	MΩ
DMS-20LCD-2, -3	0.8	1	--	MΩ
Overvoltage Protection: ①				
DMS-20LCD-0, -1, -2	--	--	±100	Volts
DMS-20LCD-3	--	--	±250	Volts
Common Mode Voltage Range ②	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ③				
Decimal Point Placement (Pins 4-6):				
Functionality	Tie to pin 3 to activate			
Logic Compatibility	TTL (on 5V-powered models)			
Backlight (Pin 9)	Tie to pin 3 to turn on backlight			
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (1 minute warm-up):				
DMS-20LCD-0 (V_{IN} = +0.19V)	--	±1	±2	Counts
DMS-20LCD-1 (V_{IN} = +1.9V)	--	±1	±2	Counts
DMS-20LCD-2 (V_{IN} = +19V)	--	±2	±3	Counts
DMS-20LCD-3 (V_{IN} = +190V)	--	±2	±3	Counts
Zero Reading (V_{IN} = 0 Volts)	"–001"	"000"	"001"	
Temperature Drift (0 to +60°C)	--	±0.2	±0.4	Cnts/°C
Power Supply Requirements (5V Models)				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
Standard Models	--	+400	+600	µA
Backlit Models	--	+35	+50	mA
Power Supply Requirements (9V Models)				
Supply Voltage	+7.5	+9.0	+14.0	Volts
Supply Current:				
Standard Models	--	+230	+350	µA
Backlit Models	--	+35	+50	mA
Display				
Display Type and Size	3½ Digit LCD, 0.37"/9.4mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–1___" for negative V_{IN} "1___" for positive V_{IN}			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–20	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.4 ounces (11 grams)			

① Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.

② Listed spec applies to 5V-powered models only. For 9V-powered models, both (–) INPUT LO (pin 12) and (+) INPUT HIGH (pin 11) must always be at least 1.5V above –BATTERY (pin 3) and at least 1.5V below +BATTERY (pin 1).

③ See Technical Notes.

Ordering Information

DMS-20LCD - 1 - 5

Input Range:
0 = ±200mV
1 = ±2V
2 = ±20V
3 = ±200V

Leave blank for standard models.
Add **B** for backlit models.

Power Source:
5 = +5V
9 = +9V

Accessories:

DMS-20-CP	Panel cutout punch
DMS-BZL3	DMS-20 bezel assembly
DMS-BZL4	DMS-20 bezel assembly with sealing gasket
DMS-EB2	Application/evaluation board with standard MOLEX connector, decimal point solder pads and attenuation resistor pads.

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **REFERENCE OUTPUT (Pin 8) and INPUT (Pin 7):** Pin 8 is a precision reference actively trimmed at the factory. In normal operation, pin 8 must be tied to pin 7 to achieve all listed accuracy and drift specifications.
2. **ANALOG COMMON (Pin 10):** This pin is connected to an internal, low-noise, "relative" ground. It is used in certain differential and "floating" measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. **Pin 10 should not be connected to pin 3 (5V RETURN/–BATTERY) or to your system's analog ground.**
3. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP3) are active low functions. Select the appropriate decimal point by tying the appropriate pin (pin 4, 5 or 6) to pin 3 (5V RETURN/–BATTERY). Unused decimal point location pins should be left open. For 5V-powered models, the decimal location pins are TTL compatible and may be hard wired as described above or driven with 5V TTL logic gates.

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4. **BACKLIGHT (Pin 9) Function:** Grounding pin 9 (i.e. connecting it to pin 3) turns on the backlighting LED's. For non-backlit models, pin 9 has no internal connection. All backlit models include internal current-limiting resistors. With nominal +5V or 9V supplies, backlit devices typically draw 35mA of supply current. The current drawn by the backlight (and therefore the current drawn by the meter) can be reduced by installing a 1/4 Watt resistor between pins 3 and 9. The brightness of the meter will be reduced proportionately.

   9V-powered backlit models function with supply voltages up to +14V, however, activating the backlight with voltages greater than 9.2V can damage the meter. Therefore, a 1/4 Watt series resistor must be installed between pins 3 and 9 in these situations. The value of the series resistor is determined using the following formula:

$$R_{Series} = \frac{+BATTERY - 9.2V}{0.035} \text{ Ohms}$$

   Example: If +BATTERY (pin 1 with respect to pin 3) is +12.6V,

$$R_{Series} = \frac{+12.6 - 9.2V}{0.035} \text{ Ohms}$$

$$R_{Series} = 97 \text{ Ohms}$$

5. **Low Battery Annunciator:** The "B" annunciator in the upper left-hand corner of the display turns on when the supply voltage for 5V-powered models falls below approximately +3.75V or when the supply voltage for 9V-powered models falls below approximately 7.2V. This function can not be disabled.
6. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±50 counts (±2.5%) range of adjustment. Since these devices essentially have no zero/offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals. The circuit shown in Figure 9 provides ±10% range of adjustment.
7. **Soldering Methods:** All models in the DMS-20LCD Series easily withstand most common wave soldering operations. We recommend, however, that you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.

8. **Suggested Mating Connectors:**

   Panel mounted:

Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)

   Board mounted:

Socket	DATEL P/N 39-2359625

Applications

DMS-20LCD meters are available in either 5V-powered or 9V-powered models. 9V devices operate directly from 7.5V to 14V supplies (usually batteries) without the need for external voltage regulators. 9V devices, however, can not be used to measure voltages referenced to the negative battery terminal (pin 3) because the minus input to the meter (pin 12, (–) INPUT LO) must always be at least 1.5V above pin 3. 9V-powered meters can only be used to make differential and not single-ended measurements.

5V-powered devices operate from any well-regulated +5V supply and will accurately measure voltages both above and below pin 3 (5V RETURN) in either single-ended or differential configurations.

1. **Single-Ended Input Configurations:** True single-ended measurements can only be made with 5V-powered meters. The circuit of Figure 2 avoids problems normally associated with ground-loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12).

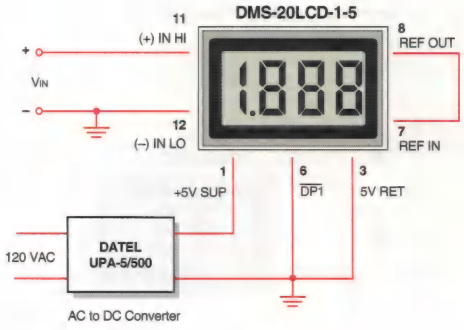

Figure 2. Single-Ended Input Configuration (5V-Powered Models)

Applications

2. **Differential Input Configurations:** Differential measurements can be made with either 5V-powered or 9V-powered meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V powered meters.

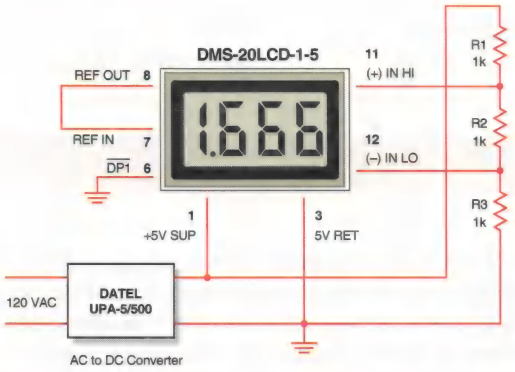

Figure 3. Differential Input Configuration (5V-Powered Models)

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal-film resistors with absolute TCR's less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

$$50k\Omega < R1 + R2 < 10M\Omega$$

$$\frac{R2}{R1 + R2} \times V_{IN} = \text{Reading}$$

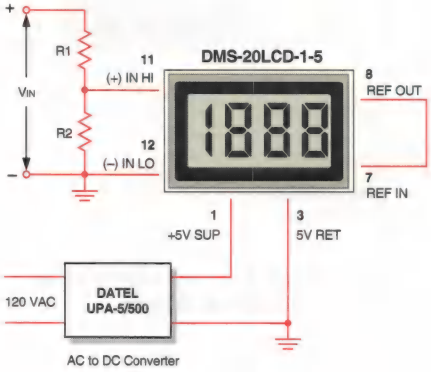

Figure 4. Input Attenuation Circuit

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6. Figure 5 uses a 5V-powered meter. Figure 6 uses a 9V-powered meter. Connecting pin 10 (ANALOG COMMON) to (–) INPUT LO (pin 12) provides the reference point for the meter's input.

   A "floating" input is a signal that has no galvanic connection to the meter's power supply. In the figures below, the 1.5V battery illustrates a true floating input.

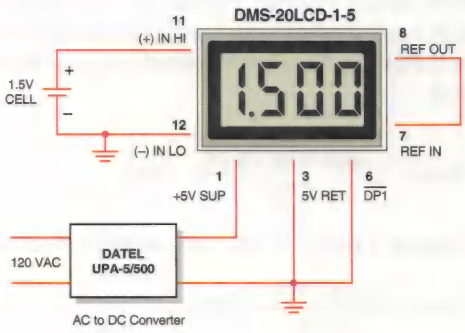

Figure 5. Floating Input Measurements (5V-Powered Models)

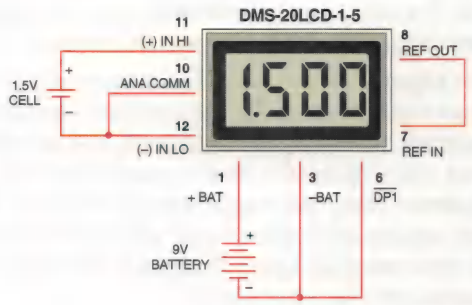

Figure 6. Floating Input Measurements (9V-Powered Models)

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-20LCD meters have such high input impedance, a simple shunt resistor across the meter's input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a

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Applications

function of the scaling requirements of the particular application and can be calculated using the following equation:

$$R_{Shunt} = R1 = V_{Fsr} / I_{Fsr}$$

Where: V_{Fsr} = Full scale reading (in Volts)

I_{Fsr} = Relative full scale current (in Amps)

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired full scale display reading of 1000 (with an input of 20mA), V_{Fsr} = 1.000 Volts

$$R_{Shunt} = 1.000V/(0.020 - 0.004)A$$

$$R_{Shunt} = 1.000V/0.016A = 62.5 \text{ Ohms}$$

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "1999". For different full scale readings, alter the value of R_{Shunt} accordingly.

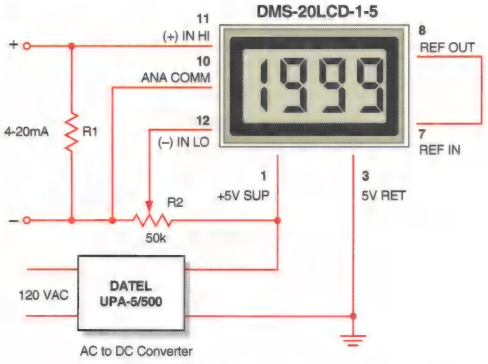


Figure 7. 4-to-20mA Current Loop Operation (5V-Powered Models)

6. **Power Supply Monitoring:** A popular application for DATEL's low-power LCD meters is monitoring the supply voltage in battery-operated portable equipment. Figure 8 demonstrates how a 9V-powered DMS-20LCD can be used to monitor its own supply. The meter used is the DMS-20LCD-1-9. A three-resistor voltage divider is used to attenuate the battery voltage and also to satisfy the requirement that the input voltages applied to pins 12 and 11 be at least 1.5 Volts above and below the battery voltage applied to pins 1 (+BATTERY) and 3 (–BATTERY). The divider should be designed so that 1/10th the battery voltage falls across the inputs to the meter:

$$\frac{R2}{(R1 + R2 + R3)} = 0.1$$

Therefore, the 9V battery voltage appears to the meter inputs as 0.9V. With the decimal point moved to its DP2 position (pin 5 tied to pin 3), the meter reads 9.00 Volts.

The circuit can be calibrated by first measuring the actual battery voltage with another meter and then adjusting the gain-adjust potentiometer on the back of the DMS-20LCD until a similar reading is obtained. If possible, the resistors in the divider should be ±1% metal-film types with TCR's less than 50ppm/°C.

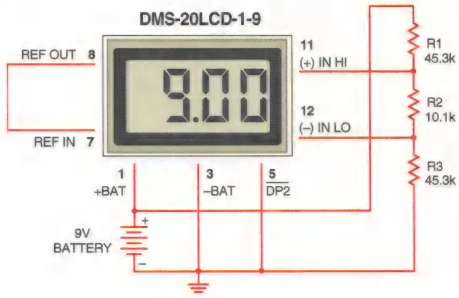


Figure 8. Power Supply Monitor (9V-Powered Models)

7. **External Gain Adjustment:** Connect REFERENCE OUT (pin 8) to REFERENCE IN (pin 7) for normal, factory calibrated, operation. Use the circuit shown in Figure 9 for applications needing external gain adjustment. Calibration is performed with a precise, near-full-scale, input voltage.

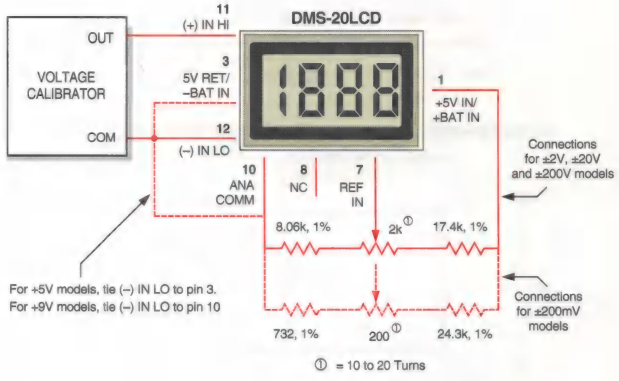
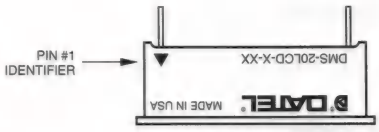


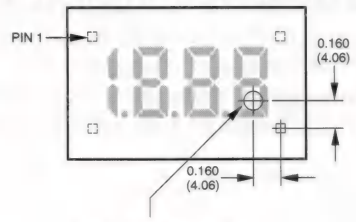
Figure 9. External Gain Adjustment

Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)

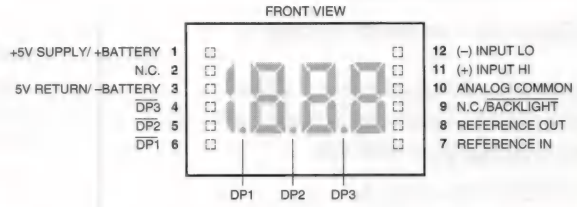


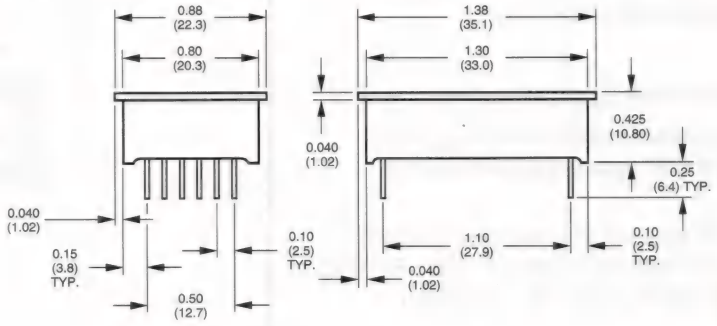
CALIBRATION POTENTIOMETER HOLE LOCATION



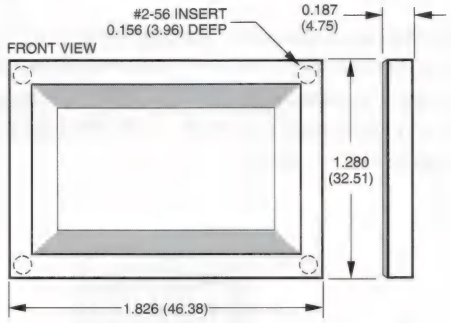
0.125 (3.175) DIAMETER
(USE ONLY WHEN PC
BOARD MOUNTING)

FRONT VIEW

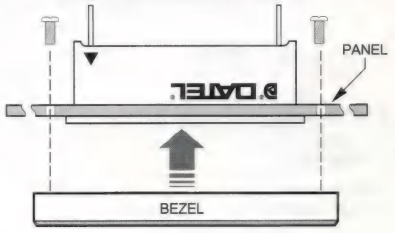




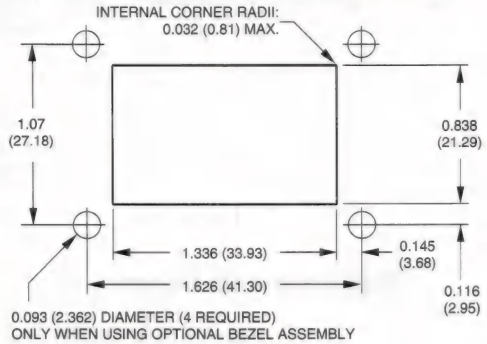
OPTIONAL BEZEL (DMS-BZL3 and DMS-BZL4)



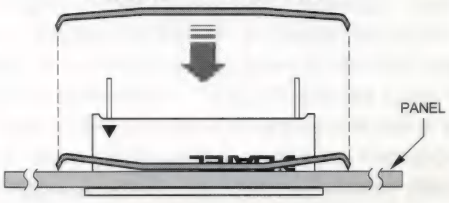
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



DS-0291 Rev. B

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Actual Size

DMS-30LCD Series

3½ Digit, LCD Display Low-Power, Miniature Digital Panel Voltmeters

Features

- Large (0.4"/10.2mm), enhanced-contrast, LCD display
- Single +5V supply or 9V battery
- Power as low as 3.2mW
- Miniature size:
  2.17" x 0.92" x 0.43"
  55mm x 23mm x 11mm
- Epoxy-encapsulated, 12-pin DIP
- Backlit displays optional
- 4 differential input voltage ranges
- High accuracy, ±1 count (±0.05%)
- Autopolarity changeover and overrange indication
- User-selectable decimal point placement
- Numerous "plug-on" application boards
- 0 to +60°C temperature range

Offering all the outstanding features and benefits of DATEL's industry leading DMS-20LCD Series of 3½ Digit LCD Panel Meters, DMS-30LCD meters offer larger, more easily readable displays at slightly higher power consumptions. Like all DMS Series LCD meters, these miniature (2.17" x 0.92" x 0.43"), epoxy-encapsulated devices offer component-like ease-of-use, outstanding reliability and easy installation in either panels or pc-cards.

DMS-30LCD devices operate from a single +5V supply or a 9V battery. Battery-operated units typically draw 350µA and consume a mere 3.2mW. Backlit models are available for low-light applications; though we have found many designers prefer DATEL's unique low-power LED meters in those circumstances.

Offering 4 optional input voltage ranges (±200mV, ±2V, ±20V or ±200V), DMS-30LCD meters have an extremely user-friendly input structure. They can be used in differential or single-ended modes. Input impedance is a minimum 800kΩ. CMRR is typically 86dB. CMV is ±2V, and inputs are overvoltage protected to ±100V.

Each meter incorporates an extremely stable, double regulated reference and is fully calibrated at our factory prior to encapsulation. We guarantee outstanding initial accuracy (±1 count) and excellent stability over temperature (±0.15 counts/°C). These extremely rugged meters are moisture and vibration proof and never require adjustment or recalibration.

For popular applications (4-to-20mA, rms-to-dc conversion, ac line power, J and K thermocouples, etc.), the DMS-30LCD Series includes a complete line of "plug-on" application boards that conveniently convert your meter into an application-specific instrument.

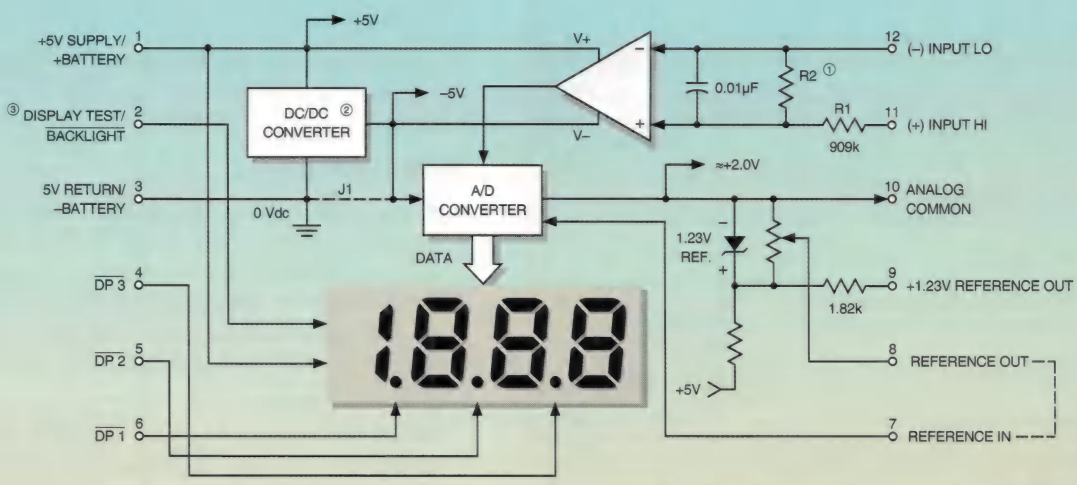

Figure 1. DMS-30LCD Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V (using the single-ended input circuit) or +9V (using the differential input circuit), unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range:				
DMS-30LCD-0	--	±200	--	mV
DMS-30LCD-1	--	±2	--	Volts
DMS-30LCD-2	--	±20	--	Volts
DMS-30LCD-3	--	±200	--	Volts
Input Impedance:				
DMS-30LCD-0, -1	100	1000	--	MΩ
DMS-30LCD-2, -3	0.8	1	--	MΩ
Overvoltage Protection ①				
DMS-30LCD-0, -1, -2	--	--	±100	Volts
DMS-30LCD-3	--	--	±250	Volts
Common Mode Voltage Range ②	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ③				
Decimal Point Placement (Pins 4-6):				
Functionality	Tie to pin 3 to activate			
Logic Compatibility	TTL (on 5V-powered models)			
Display Test (Pin 2)	Tie to pin 1 to activate			
Backlight (Pin 2)	Tie to pin 3 to turn on backlight			
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (1 minute warm-up):				
DMS-30LCD-0 (V_{IN} = +0.19)	--	±1	±2	Counts
DMS-30LCD-1 (V_{IN} = +1.9V)	--	±1	±2	Counts
DMS-30LCD-2 (V_{IN} = +19V)	--	±2	±3	Counts
DMS-30LCD-3 (V_{IN} = +190V)	--	±2	±3	Counts
Zero Reading (V_{IN} = 0 Volts)	"–001"	"000"	"001"	
Temperature Drift (0 to +60°C)	--	±0.15	±0.3	Cnts/°C
+1.23V Reference Out (Pin 9)	+1.20	+1.23	+1.25	Volts
Power Supply Requirements (5V Models)				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
Standard Models	--	800	1200	µA
Backlit Models	--	45	60	mA
Power Supply Requirements (9V Models)				
Supply Voltage	+7.5	+9.0	+14.0	Volts
Supply Current:				
Standard Models	--	350	600	µA
Backlit Models	--	45	60	mA
Display				
Display Type and Size	3½ Digit LCD, 0.4"/10.2mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–1___" for negative V_{IN} "1___" for positive V_{IN}			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–20	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.75 ounces (21 grams)			

① Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.

② Listed spec applies to 5V-powered models only. For 9V-powered models, both (–) INPUT LO (pin 12) and (+) INPUT HIGH (pin 11) must always be at least 1.5V above –BATTERY (pin 3) and at least 1.5V below +BATTERY (pin 1).

③ See Technical Notes.

Ordering Information

DMS-30LCD - 1 - 5

Input Range:
0 = ±200mV
1 = ±2V
2 = ±20V
3 = ±200V

Leave blank for standard models.
Add **B** for backlit models.

Power Source:
5 = +5V
9 = +9V

Accessories:

DMS-30-CP	Panel cutout punch
DMS-BZL1	DMS-30 bezel assembly
DMS-BZL2	DMS-30 bezel assembly with sealing gasket
RN-DMS	Gain/offset potentiometer kit for DMS-EB, DMS-EB-AC/DC and DMS-EB-DC/DC

Add-On Application Boards:

DMS-EB	Multi-purpose (gain/offset, 4-20mA, etc.)
DMS-EB-HTB	High-accuracy temperature probe sensing for ±200mV models
DMS-EB-DC/DC	Provides isolated +5V power
DMS-EB-TCJ	J-type thermocouple inputs for ±2V models
DMS-EB-TCK	K-type thermocouple inputs for ±2V models
DMS-EB-RMS	For true rms measurements of ac voltages
DMS-EB-AC/DC	For ac line-powered applications
DMS-EB-LP	For 4-to-20mA loop-powered applications

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **+1.23V REFERENCE OUTPUT (Pin 9):** This pin is the output of the meter's precision +1.23V internal reference, and it is referenced to ANALOG COMMON (pin 10) which sits at a potential of approximately +2V. This output should be buffered if used to drive external loads since sourcing more than 15µA from pin 9 can affect both the initial accuracy and temperature drift of the meter.
2. **ANALOG COMMON (Pin 10):** This pin is connected to an internal, low-noise, "relative" ground. It is used in certain differential and "floating" measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. **Pin 10 should not be connected to pin 3 (5V RETURN/ –BATTERY) or to your system's analog ground.**

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3. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP3) are active low functions. Select the appropriate decimal point by tying the appropriate pin (pin 4, 5 or 6) to pin 3 (5V RETURN/ –BATTERY). Unused decimal point location pins should be left open. For 5V-powered models, the decimal location pins are TTL compatible and may be hard wired as described above or driven with 5V TTL logic gates.
4. **REFERENCE OUTPUT (Pin 8) and INPUT (Pin 7):** Pin 8 is a precision reference actively trimmed at the factory. In normal operation, pin 8 must be tied to pin 7 to achieve all listed accuracy and drift specifications.
5. **DISPLAY TEST (Pin 2):** (Not available on backlit models) Connect DISPLAY TEST (pin 2) to +5V SUPPLY/+BATTERY (pin 1) to activate. All LCD segments, exclusive of the decimal points, will be momentarily enabled. **Do not leave the unit in the TEST mode for more than 10 seconds as this will damage the LCD segments.**
6. **BACKLIGHT (Pin 2) Function:** For backlit models, grounding pin 2 (i.e. connecting it to pin 3) turns on the backlighting LED's. 9V-powered backlit models function with supply voltages up to +14V, however, activating the backlight with voltages greater than 9.2V can damage the meter. Therefore, a 1/4 Watt series resistor must be installed between pins 3 and 2 in these situations. The value of the series resistor is determined using the following formula:

$$R_{Series} = \frac{+BATTERY - 9.2V}{0.035} \text{ Ohms}$$

Example: If +BATTERY (pin 1 with respect to pin 3) is +12.6V,

$$R_{Series} = \frac{+12.6 - 9.2V}{0.035} \text{ Ohms}$$

R_{Series} = 97 Ohms

In any backlit application, including those with supply voltages < 9.2V, the current drawn by the backlight (and therefore the current drawn by the meter) can be reduced by installing a 1/4 Watt resistor between pins 3 and 2. The brightness of the backlight will be reduced proportionately.

7. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±50 counts (±2.5%) of adjustment range. Since these devices essentially have no zero/ offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals. Refer to Figure 9 for applications requiring greater (±10%) gain adjustments.
8. **Soldering Methods:** All models in the DMS-30LCD Series easily withstand most common wave soldering operations. We recommend, however, you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.
9. **Suggested Mating Connectors:**

Panel mounted:

Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)

Board mounted:

Socket	DATEL P/N 39-2359625

Applications

DMS-30LCD meters are available in either 5V-powered or 9V-powered models. 9V devices operate directly from 7.5V to 14V supplies (usually batteries) without the need for external voltage regulators. 9V devices, however, can not be used to measure voltages referenced to the negative battery terminal (pin 3) because the minus input to the meter (pin 12, (–) INPUT LO) must always be at least 1.5V above pin 3. 9V-powered meters can only be used to make differential and not single-ended measurements.

5V-powered devices operate from any well-regulated +5V supply and will accurately measure voltages both above and below pin 3 (5V RETURN) in either single-ended or differential configurations.

1. **Single-Ended Input Configurations:** True single-ended measurements can only be made with 5V-powered meters. The circuit of Figure 2 avoids problems normally associated with ground-loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12).

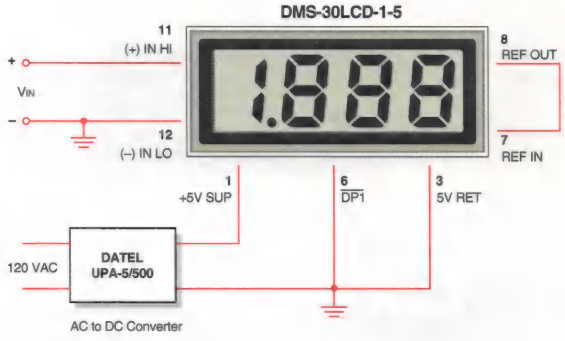

Figure 2. Single-Ended Input Configuration (5V-Powered Models)

Applications

2. **Differential Input Configurations:** Differential measurements can be made with either 5V-powered or 9V-powered meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V-powered meters.

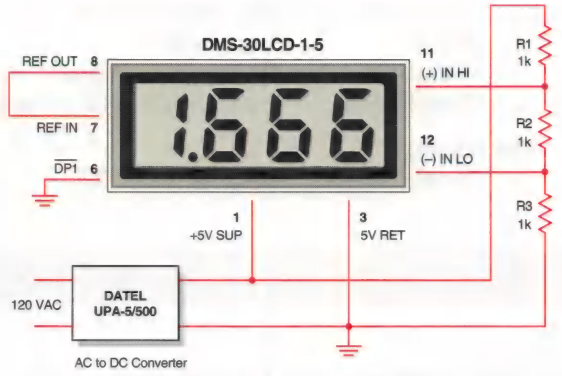

Figure 3. Differential Input Configuration (5V-Powered Models)

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal-film resistors with absolute TCR's less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

$$50k\Omega < R1 + R2 < 10M\Omega$$

$$\frac{R2}{R1 + R2} \times V_{IN} = \text{Reading}$$

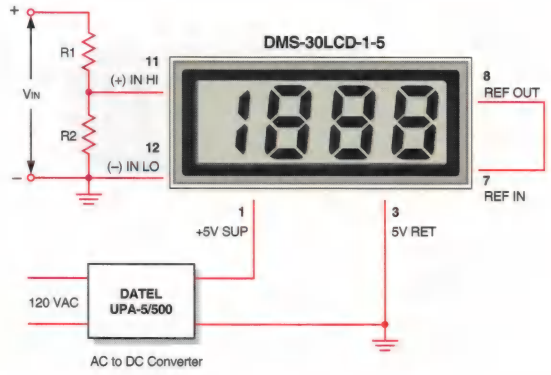

Figure 4. Input Attenuation Circuit

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6. Figure 5 uses a 5V-powered meter. Figure 6 uses a 9V-powered meter. Connecting pin 10 (ANALOG COMMON) to (–) INPUT LO (pin 12) provides the reference point for the meter's input.

   A "floating" input is a signal that has no galvanic connection to the meter's power supply. In the figures below, the 1.5V battery illustrates a true floating input.

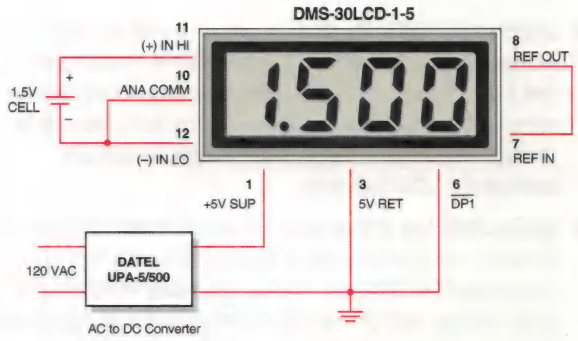

Figure 5. Floating Input Measurements (5V-Powered Models)

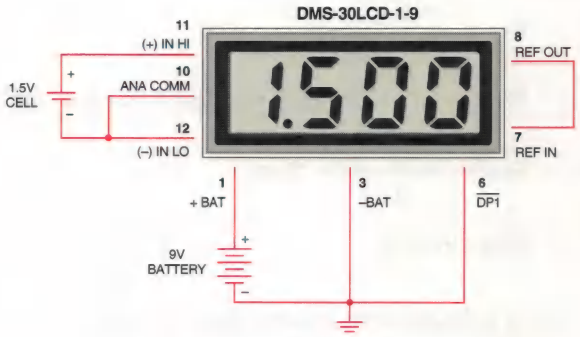

Figure 6. Floating Input Measurements (9V-Powered Models)

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-30LCD meters have such high input impedance, a simple shunt resistor across the meter's input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a

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Applications

function of the scaling requirements of the particular application and can be calculated using the following equation:

$$R_{Shunt} = R1 = V_{Fsr} / I_{Fsr}$$

Where: V_{Fsr} = Full scale reading (in Volts)

I_{Fsr} = Relative full scale current (in Amps)

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired full scale display reading of 1000 (with an input of 20mA), V_{Fsr} = 1.000 Volts

$$R_{Shunt} = 1.000V/(0.020 - 0.004)A$$

$$R_{Shunt} = 1.000V/0.016A = 62.5 \text{ Ohms}$$

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "1999". For different full scale readings, alter the R_{Shunt} value accordingly.

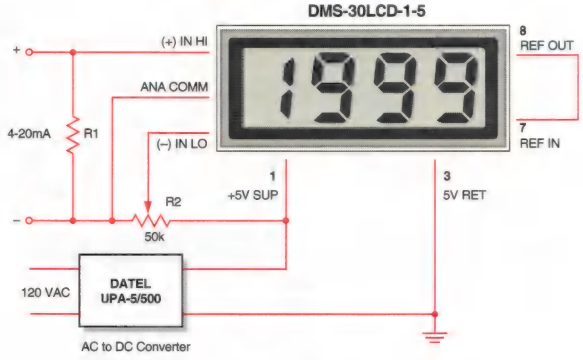


Figure 7. 4-to-20mA Current Loop Operation (5V-Powered Models)

6. **Power Supply Monitoring:** A popular application for DATEL's low-power LCD meters is monitoring the supply voltage in battery-operated portable equipment. Figure 8 demonstrates how a 9V-powered DMS-30LCD can be used to monitor its own supply. The meter used is the DMS-30LCD-1-9. A three-resistor voltage divider is used to attenuate the battery voltage and also to satisfy the requirement that the input voltages applied to pins 12 and 11 be at least 1.5 Volts above and below the battery voltage applied to pins 1 (+BATTERY) and 3 (–BATTERY). The divider should be designed so that 1/10th the battery voltage falls across the inputs to the meter:

$$\frac{R2}{(R1 + R2 + R3)} = 0.1$$

Therefore, the 9V battery voltage appears to the meter inputs as 0.9V. With the decimal point moved to its DP2 position (pin 5 tied to pin 3), the meter reads 9.00 Volts.

The circuit can be calibrated by first measuring the actual battery voltage with another meter and then adjusting the gain-adjust potentiometer on the back of the DMS-30LCD until a similar reading is obtained. If possible, the resistors in the divider should be ±1% metal-film types with TCR's less than 50ppm/°C.

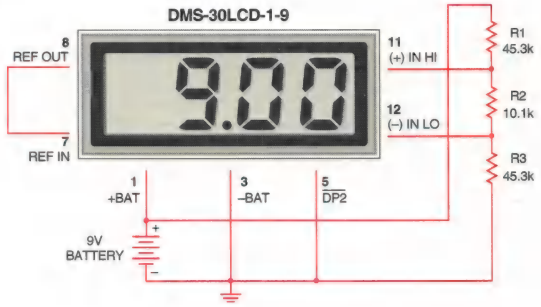


Figure 8. Power Supply Monitor (9V-Powered Models)

7. **External Gain Adjustment:** Connect REFERENCE OUT (pin 8) to REFERENCE IN (pin 7) for normal, factory calibrated, operation. Use the +1.23V REFERENCE OUT (pin 9) for applications needing external gain adjustment. Figure 9 shows the wiring configuration for each model. Calibration is performed with a precise, near-full-scale, input voltage.

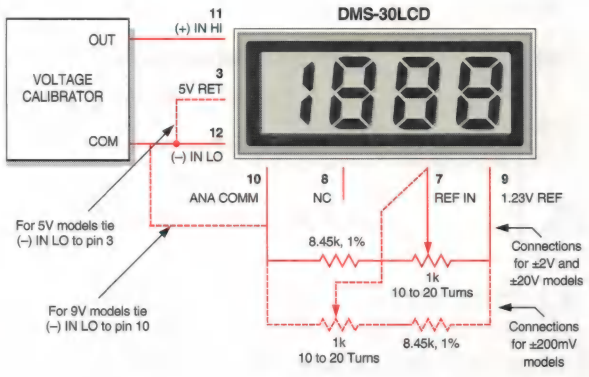
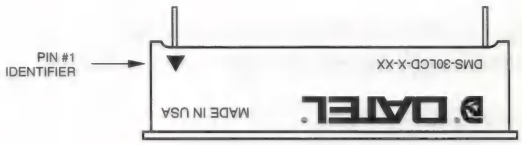


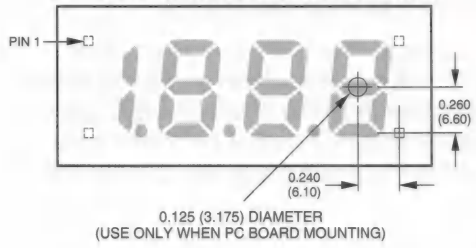
Figure 9. External Gain Adjustment

Mechanical Specifications

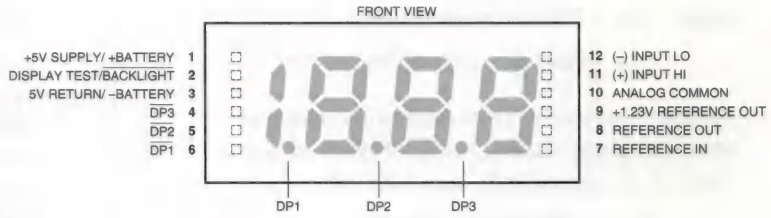
MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)

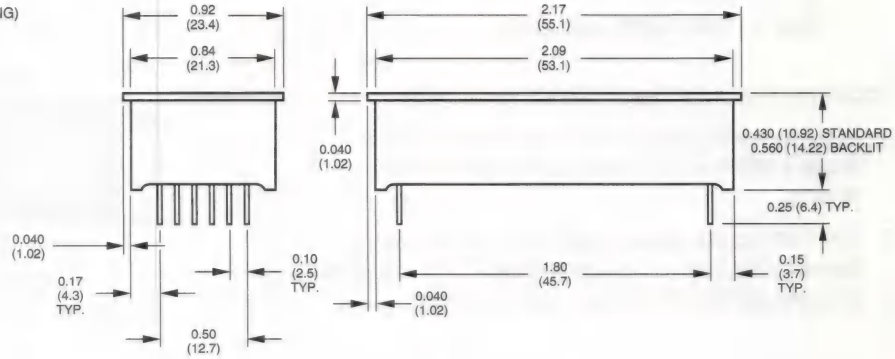


CALIBRATION POTENTIOMETER HOLE LOCATION

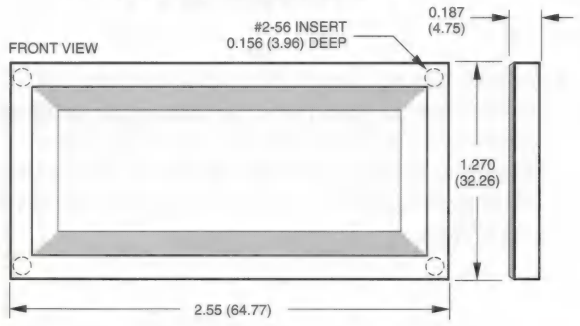


FRONT VIEW

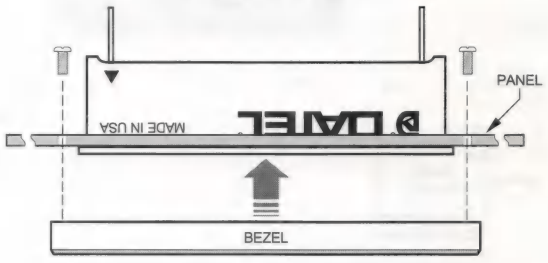




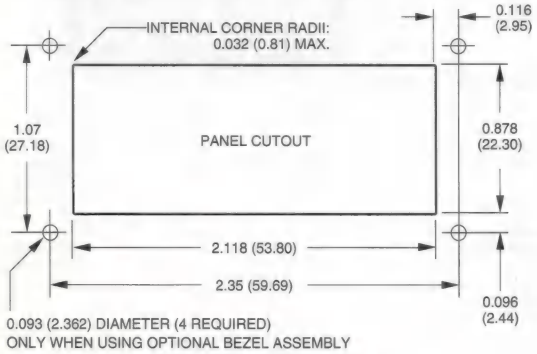
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



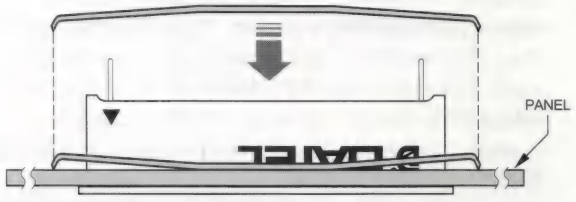
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



DS-0259 Rev. C

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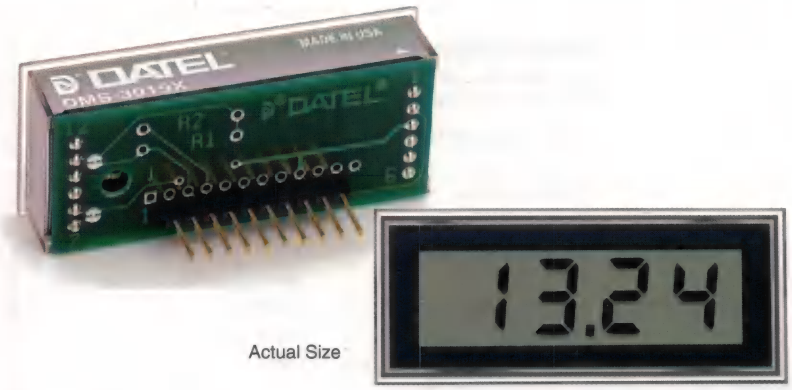


Actual Size

DMS-3019X Series

Alternate Source for DP-650 Series, 3½ Digit, LCD Display Digital Panel Voltmeters

1

Features

- Replaces DP-650, DP-652 and DP-654 meters
- Connects directly to existing wiring
- Available in three input ranges: ±200mV, ±2V and ±20V
- Low power consumption
- Wider operating temperature range (0 to +60°C)
- Rugged, epoxy-encapsulated plastic packages
- Large (0.4"/10.2mm) LCD displays
- Made in the USA!

DATEL's new DMS-3019X Series, 3½ Digit, LCD Display, Digital Panel Voltmeters provide DP-650 users with a superior-quality alternate source. The DMS-3019X Series input/output connector is pin-compatible with nearly all DP-650 applications. Only minor sheet-metal modifications are needed to attain all the advantages offered by the DMS-3019X Series digital voltmeters.

Three differential, high-impedance, input voltage ranges are available: ±200mV (DMS-30193), ±2V (DMS-30194) and ±20V (DMS-30195). Provisions are also included for the addition of custom input-scaling resistors—a feature found only on DMS-3019X meters. Autozero calibration, autopolarity changeover and a factory-calibrated ultra-stable reference circuit are standard. A reliable, epoxy-encapsulated DMS-30LCD digital voltmeter, with large (0.4"/10.2mm) LCD digits, is used in all three models. All internal and external connections are 100% soldered—no elastomeric connectors are used.

The DMS-3019X Series offers many noteworthy improvements over its competitors: wider operating temperature range, lower power consumption and higher input impedance, to name a few. And, most importantly, all DATEL digital panel meters are designed and manufactured in the USA!

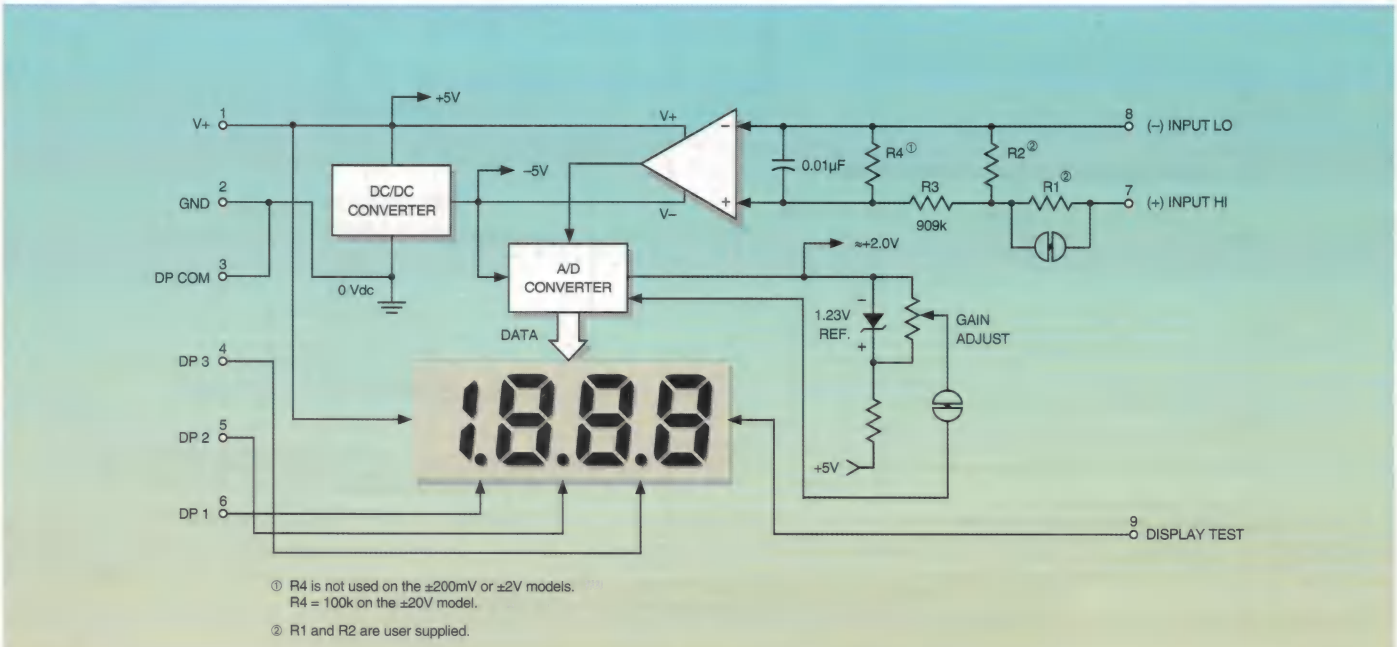


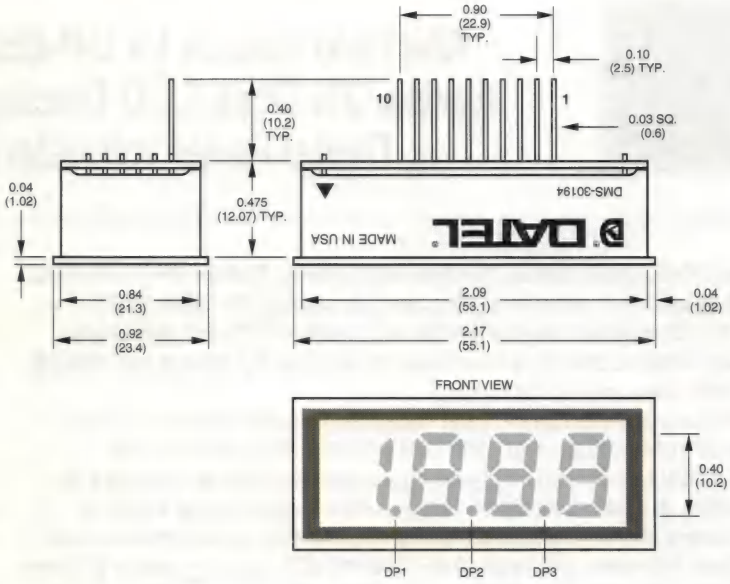
Figure 1. DMS-3019X Simplified Schematic

Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)

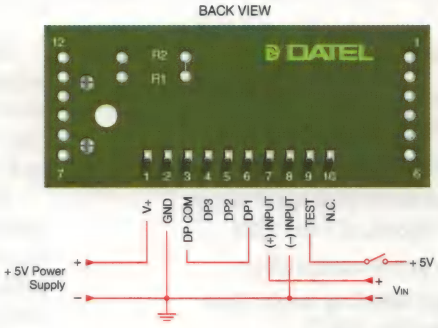
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL



Electrical Specifications

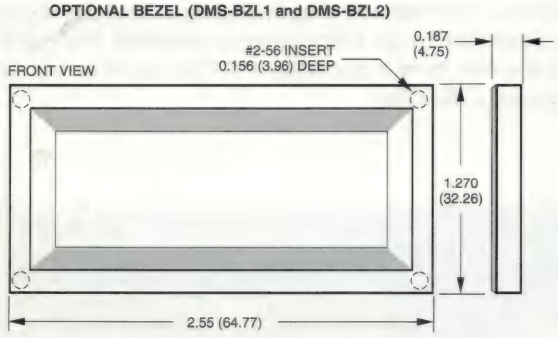
Typical at T_A = +25°C and supply voltage = +5V. See DMS-30LCD data sheet for more information.

Power Supply (V+ to GND)	+5Vdc, ±5% @ 1.2mA max.
Full Scale Input	See Ordering Information
Input Impedance	1 Megohm
Sampling Rate	3 Samples per second
Accuracy (V_{IN} = +0.190V)	±2 Counts max. (±0.1%)
Display Type	3½ Digit LCD, 0.40"/10.2mm high
Operating Temperature	0 to +60°C
Storage Temperature	–20 to +75°C
Humidity (Non-condensing)	0-95%

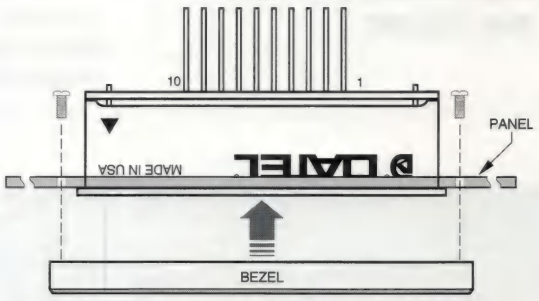


Typical Single-ended Connections

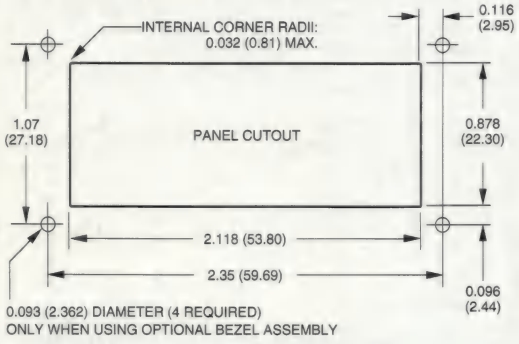
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



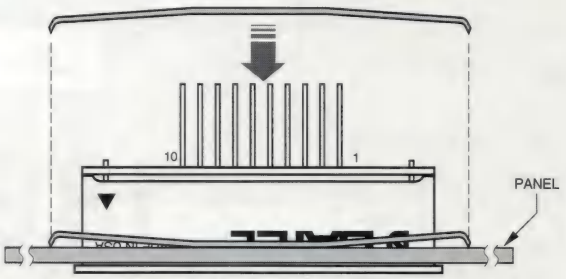
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



A panel-mount retaining clip is supplied with all models

DS-0330 Rev. A

Ordering Information

DMS-30193	±200mV input	**DMS-BZL1**	Bezel assembly
DMS-30194	±2V input	**DMS-BZL2**	Bezel with gasket
DMS-30195	±20V input	**DMS-30-CP**	Panel cutout punch

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4½ Digit Voltmeters and Slave Displays

For high-resolution, high-accuracy, digital panel meter applications, there is no better combination of performance, size, reliability and price than that offered by DATEL's DMS-40PC Series (LED displays) and DMS-40LCD Series (LCD displays) 4½ digit DPM's. These fully self-contained, component-like, plug-in meters provide scientific-grade accuracy and outstanding reliability at very affordable prices.

LED meters are available in five different colors, including DATEL's unique low-power models. LCD meters are available with or without backlighting. All operate from single supplies and are packaged in miniature 2.17" x 0.92" packages whose epoxy encapsulation provides a measure of vibration, shock and moisture resistance simply not found in competing meters.

These are the right DPM's for all your high-performance applications. From trouble-free installation to long-term, calibration-free operation in the harshest of environments, DMS-40 meters deliver high performance and peace of mind.

2

Table of Contents

Selection Guides 2-2

4½ Digit, LED Display, Digital Panel Voltmeters

DMS-40PC Series 2-3

4½ Digit, LCD Display, Digital Panel Voltmeters

DMS-40LCD Series 2-9

4½ Digit, LED Slave Displays

DSD-40BCD Series 2-15

Selection Guides

4½ Digit Meters, LED Displays

DMS-40PC Series

Page 2-3

LED Height: 0.52"/13.2mm
Package Size: 2.17" x 0.92" x 0.56"
55mm x 23mm x 14mm

Actual Size

Display Colors
- Green
- Red
- Super Red
- Low-Power Red
- Yellow

Input Ranges
- ±2V
- ±20V
- ±200V

Display Functions
- DP Placement
- BCD Outputs
- Overrange
- Test
- Hold

4½ Digit Meters, LCD Displays

DMS-40LCD Series

Page 2-9

LCD Height: 0.4"/10.2mm
Package Size: 2.17" x 0.92" x 0.43"
55mm x 23mm x 11mm

Actual Size

Display Type
- Standard
- Backlit

Display Functions
- DP Placement
- Backlight
- Low Battery
- Overrange
- Hold

Input Ranges
- ±200mV/±2V
- ±2V/±20V
- ±20V/±200V

Power Supply
- 5 Volt
- 9 Volt

4½ Digit, LED Slave Displays

DSD-40BCD Series

Page 2-15

LED Height: 0.52"/13.2mm
Package Size: 2.17" x 0.92" x 0.56"
55mm x 23mm x 14mm

Actual Size

Display Color
- Green
- Red
- Low-Power Red

Power Supply
- 5 Volt

Display Functions
- DP Placement
- Brightness Control
- Minus Sign
- Test

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Actual Size

DMS-40PC Series

4½ Digit, LED Display Precision, Miniature Digital Panel Voltmeters

Features

- Precision, autozeroing, factory-calibrated A/D converter
- Scientific-grade accuracy, ±2 counts
- Miniature size:
  2.17" x 0.92" x 0.56"
  55mm x 23mm x 14mm
- Large (0.52"/13.2mm) LED display
- Choice of red, green or yellow colors
- High-intensity or low-power red LED's optional
- Single +5V supply (175mW for low-power models)
- Epoxy-encapsulated, 12-pin DIP with built-in color filter and bezel
- 3 differential input voltage ranges
- DISPLAY HOLD and TEST functions
- Optional BCD data outputs for CPU interface
- 0 to +50°C temperature range

DMS-40PC Series, 4½ Digit, LED Display, Miniature DPM's are fully self-contained, component-like, plug-in meters that provide scientific-grade accuracy (typically ±2 counts or ±0.005% of full scale) and outstanding reliability at a very affordable price.

Within its miniature (2.17" x 0.92" x 0.56"), epoxy-encapsulated package, each meter contains a precision reference circuit; a high-resolution, autozeroing, factory-calibrated A/D converter; and a large (0.52"/13.2mm), easy-to-read, LED display. LED's are available in red, yellow and green colors. Red LED's are also offered in high-intensity or low-power versions.

The versatile design of the DMS-40PC Series assures trouble-free installation and long-term operation. Differential input voltage ranges include ±2V, ±20V and ±200V. Input impedance is a minimum 800kΩ. Non-inverting inputs are overvoltage protected to ±250V, and CMRR is typically 86dB (dc to 60Hz).

The DMS-40PC's epoxy-encapsulated package has an integral bezel and color filter. The moisture and vibration-proof package is extremely rugged and well suited for harsh environments and extended temperatures. Devices are fully specified for 0 to +50°C operation.

All models operate from a single +5V supply and typically consume 500mW. Low-power models, whose display is just as bright as standard models, typically consume 175mW. DISPLAY TEST and HOLD functions are standard on each meter, and a complete set of BCD outputs are optional for sending data to CPU's or remote displays.

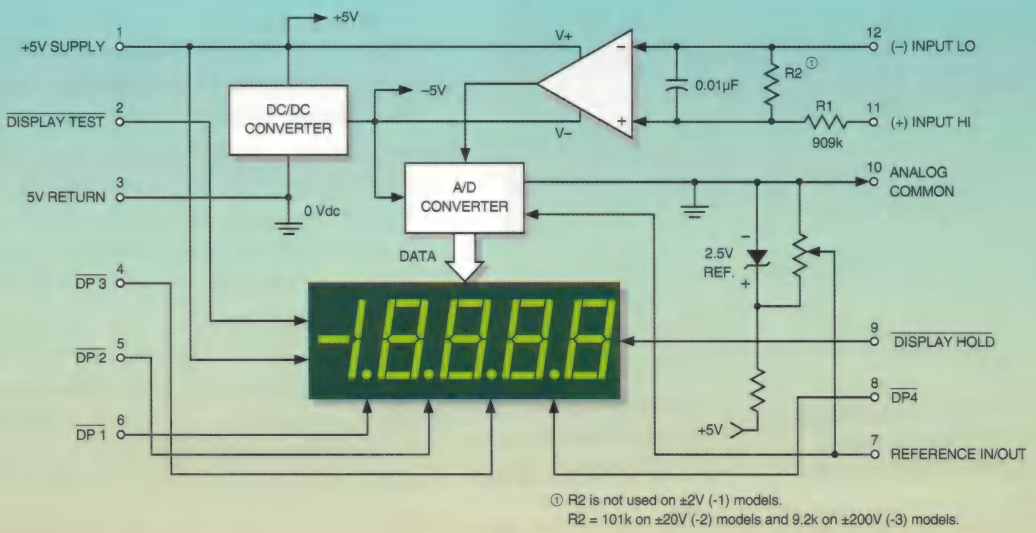

Figure 1. DMS-40PC Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V using the single-ended input circuit, unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range:				
DMS-40PC-1	--	±2	--	Volts
DMS-40PC-2	--	±20	--	Volts
DMS-40PC-3	--	±200	--	Volts
Input Impedance:				
DMS-40PC-1	100	1000	--	MΩ
DMS-40PC-2, -3	0.8	1	--	MΩ
Overvoltage Protection ①	--	--	±250	Volts
Common Mode Voltage Range	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ②				
Decimal Point Placement (Pins 4-6, 8)	Tie to pin 3 to activate			
Display Test (Pin 2)	Tie to pin 3 to activate all segments			
Display Hold (Pin 9)	Tie to pin 3 to hold last reading			
BCD Outputs ③				
Logic levels (1 LSTTL load max.):				
Logic "1"	+2.4	--	--	Volts
Logic "0"	--	+0.4	+0.8	Volts
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (15 minute warm-up):				
DMS-40PC-1 (V_{IN} = +1.9V)	--	±2	±3	Counts
DMS-40PC-2 (V_{IN} = +19V)	--	±3	±4	Counts
DMS-40PC-3 (V_{IN} = +190V)	--	±3	±4	Counts
Zero Reading (V_{IN} = 0 Volts)	"–0001"	"0000"	"0001"	
Temperature Drift (0 to +50°C):				
DMS-40PC-1	--	±0.4	±1	Cnts/°C
DMS-40PC-2, -3	--	±0.4	±1.5	Cnts/°C
Power Supply Requirements				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
Standard Models ④	--	+100	+140	mA
Low-Power Models	--	+35	+50	mA
Display				
Display Type and Size	4½ Digit LED, 0.52"/13.2mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–0000" (flashing) for negative V_{IN} "0000" (flashing) for positive V_{IN}			
Physical/Environmental				
Operating Temperature	0	--	+50	°C
Storage Temperature	–20	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.75 ounces (21 grams)			

① Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.
② See Technical Notes.
③ BCD outputs are optional and must be specified in the part number. See Ordering Information.
④ Includes high-intensity and BCD-output models.

Ordering Information

DMS-40PC - 1 - RS

Input Range:
1 = ±2V
2 = ±20V
3 = ±200V

LED Color:
GS = Standard Green
RH = High-Intensity Red
RL = Low-Power Red
RS = Standard Red
YS = Standard Yellow

BCD Output Models:
BCD outputs are only available on standard red meters.
DMS-40PC-1-RS-BCD for ±2V input range
DMS-40PC-2-RS-BCD for ±20V input range
DMS-40PC-3-RS-BCD for ±200V input range
DMS-40PC-1-RL-BCD for ±2V input range
DMS-40PC-2-RL-BCD for ±20V input range
DMS-40PC-3-RL-BCD for ±200V input range

Accessories:

DMS-30-CP	Panel cutout punch
DMS-BZL1	DMS-40 bezel assembly
DMS-BZL2	DMS-40 bezel assembly with sealing gasket
DMS-EB	Application/evaluation board with standard MOLEX connector, decimal point solder pads and attenuation resistor pads.

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **ANALOG COMMON (Pin 10):** This pin is an internal, low-noise ground for the DMS-40PC. It is internally connected to pin 3 (5V RETURN). **Do not connect pin 10 to either pin 3 or your system ground** as this will create a ground loop and possibly result in erroneous readings.
2. **REFERENCE INPUT/OUTPUT (Pin 7):** This pin accesses the meter's internal reference and is used during the factory calibration procedure. Pin 7 should be left open in most common applications. It can be used in certain "ratiometric" applications in which it is desirable for the meter's reference to track an external reference. See Ap Note 3 in the DATEL Panel Meter Catalog for more details.
3. **DISPLAY TEST (Pin 2):** Connecting pin 2 to ground (pin 3, 5V RETURN) will activate all LED segments, and the display will read "–18888" regardless of the actual applied input. To reduce self-heating, **the display should not be left in the "test" mode for more than 10 seconds**. This pin should be left open if unused.
4. **DISPLAY HOLD (Pin 9):** For normal operation, this pin should be left open. To hold the meter's last reading and display it continuously, tie pin 9 to ground (pin 3, 5V RETURN).
5. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP4) are active low functions. Select the appropriate decimal point by tying pin 4, 5, 6 or 8 to pin 3 (5V RETURN). Unused decimal point location pins should be left open.

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Hard wiring is preferable, however, you can exercise dynamic control over the location of the decimal point by employing drive circuits that are capable of sinking a minimum of 20mA at voltages less than +0.4 Volts.

6. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±150 counts of adjustment range. Since these meters essentially have no zero/offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals.
7. **Soldering Methods:** All models in the DMS-40PC Series easily withstand most common wave soldering operations. We recommend, however, that you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.
8. **Suggested Mating Connectors:**

Panel mounted:	
Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)
Board mounted:	
Socket	DATEL P/N 39-2359625

Applications

DMS-40PC Series meters are high-precision versatile devices that can be used in many applications requiring a 0 to 19,999 count digital display. The application circuits chosen for this section are ones that have historically received many inquiries. Every attempt has been made to ensure technical accuracy, and all of the following circuits have been prototyped and tested to ensure functionality. Please keep in mind, however, that real-world applications are seldom as straightforward as the approaches presented here.

All inputs applied to DMS-40PC meters must be steady, dc values, otherwise the input itself may cause display instabilities. Due to their 4½ digit resolution, DMS-40PC meters must be wired with greater care than their 3½ digit counterparts. Correct power-supply and input-signal wiring — an absolute must! — helps eliminate ground-loop induced errors that show up as unstable display readings. When an input signal, assumed to be exactly zero volts, has a 1mV (0.001V) ground-loop induced offset, it is displayed as "0010" on a ±2V input-range meter! DATEL's new Digital Panel Meter Catalog contains an application note describing power supply wiring and ground loop avoidance techniques.

The DMS-40PC's simplified schematic, shown in Figure 1, can be very useful when debugging a malfunctioning circuit, especially if the user has some knowledge of operational amplifiers (op amps). The meter's high-impedance input consists of an op amp powered from a ±5Vdc power supply (the –5V is internally generated). Figure 1 shows that input signals applied to (–) INPUT LO and (+) INPUT HI must to be kept within the ±5V power-supply rails. Also note that only pin 11 has a current-limiting 909kΩ series resistor. High input voltages that have a common ground connection with pin 3 (5V RETURN) should only be applied to pin 11 ((+) INPUT HI) and never to pin 12. In these high-voltage cases, pin 12 should always be tied to pin 3 (5V RETURN).

One of the simplified schematic's more noteworthy features is that it shows some DMS-40PC internal voltage values and also that pin 3 is the meter's zero-volt reference point — regardless of the type of power or signal source used. This is an important point to keep in mind when using digital multimeters to perform system-level measurements. The multimeter's negative lead (usually the black one) must always be connected to pin 3 (5V RETURN). This is the only way accurate readings can be made, particularly if the meter is configured for a differential input and concerns arise regarding common-mode voltages.

1. **Single-Ended Input Configurations:** The DMS-40PC can measure single-ended signals with either positive or negative polarities. True single-ended inputs always have one of their two terminals at the same potential as the DMS-40PC's 5V RETURN (pin 3). Single-ended inputs are usually derived from power supplies that have a common ground with the meter's +5V supply. Figure 2 shows the recommended connections to be used with this type of input. Pin 12, (–) INPUT LO, is shown directly tied to ground. This connection to ground must be a separate wire or pc-board trace originating at V_{IN}'s negative terminal. This hook-up will normally eliminate display instabilities and errors caused by ground-loop currents which can occur if (–) INPUT LO is tied to ground at, or near, pin 3.

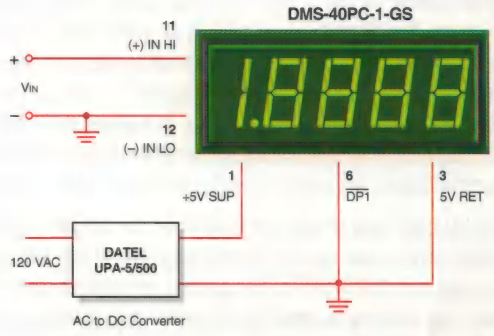

Figure 2. Single-Ended Input Configuration

Applications

2. **Differential Input Configurations:** Differential inputs can also be measured with DMS-40PC meters as shown in the circuit of Figure 3. Differential inputs must also originate from power supplies that have a common ground with the meter's 5V RETURN (pin 3). However, differential inputs usually have both terminals above and/or below 5V RETURN. Figure 3, though not necessarily a typical real-world application, does serve the purpose of illustrating the concept of a differential signal.

   The voltages developed across R1, R2 and R3 are equal to each other and measure approximately +1.6666Vdc or 1/3 of the +5V power source. More importantly, while the signal across R3 is single-ended, both ends of R1 and R2 are well above ground and are described here as being differential. Please note that while the DMS-40PC can measure the voltages across either R2 or R3, it cannot measure the +1.6666 volts across R1! The voltage at the lower end of R1 is approximately 3.333V and this exceeds the common mode voltage limit of ±2V.

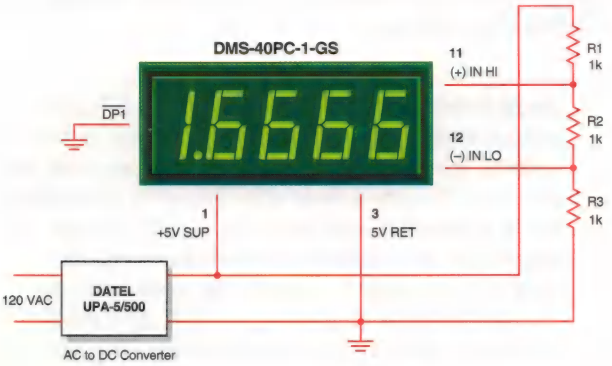

Figure 3. Differential Input Configuration

3. **Power Supply Monitoring:** One of the most widely used digital panel voltmeter applications is monitoring the output voltage of a system power supply — often the same supply that also powers the meter. The low-power, red LED DMS-40PC-2-RL, with its excellent 0.001Vdc resolution, can be configured to monitor power supplies with outputs in the range of 4.5-18Vdc. The circuit in Figure 4 uses a low-drop-out, three-terminal regulator (LM-2931T-5, in a T0-220 package, available from National Semiconductor) to provide regulated 5V power to the meter.

   The LM-2931 was chosen because it has the following on-chip protection features: reverse polarity, short circuit and thermal runaway. The DMS-40PC-3-RL can monitor voltages up to ±200Vdc, provided a separate +5V power source is used since many three-terminal regulators cannot operate with supply voltages greater than 24V. Red, low-power LED models, with their very low self-heating, are recommended for applications in which low calibration drift is desirable. When using other, higher-power, DMS-40PC models in combination with three-terminal regulators, be sure to consult the regulator manufacturer's data sheet to ensure the device is being utilized safely and correctly.

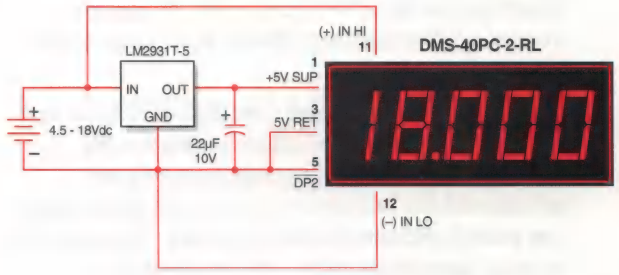

Figure 4. 4.5-18V Power Supply Monitor

4. **Floating Signal Source Measurements:** A floating input is a signal that, before it is applied to the DMS-40PC's inputs, has no galvanic connection (direct current path) to the meter or the meter's power supply. The circuit shown in Figure 5 illustrates the necessary connections for measuring floating inputs. The 1.5V battery represents a true floating input signal since it initially has no connection whatsoever in common with the meter. Real-world floating inputs typically originate from power supplies which are transformer isolated from the DMS-40PC's +5V supply.

   The connection of pin 12 ((–) INPUT LO) to pin 10 (ANALOG COMMON) is required in order to provide a bias return for the meter's input amplifier. This is because neither pin 11 nor pin 12 are tied to any reference voltage inside the DMS-40PC (see Figure 1). These connections are not made internally in order to give the meter the ability to make differential measurements as described in a previous section.

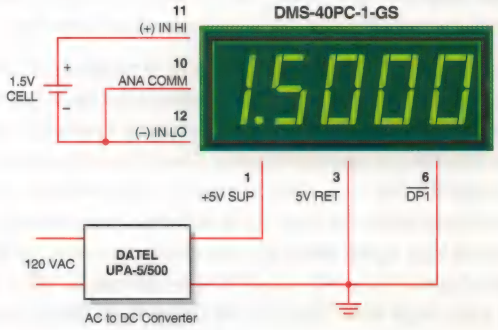

Figure 5. Floating Input Measurements

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Applications

5. **Engineering Scaling and Input Attenuation:** In many applications, the input signal must be scaled, or divided down, before being applied to the DMS-40PC. In some situations, the input signal exceeds the full-scale range of the meter, and in other applications, a direct one-to-one relation does not exist between the input voltage and the desired display reading. For an example of the second situation, assume an input voltage of 1.0Vdc is required to display a reading of "7500" when applied to a ±2V input meter. An input divider circuit, constructed with two series resistors with an output-to-input ratio of 0.75, will scale the 1.0V signal down to 0.75V.

   Engineering scaling and input attenuation are discussed in Ap Note 4 of the DATEL Digital Panel Voltmeter Catalog. Compensating for inputs which have a zero offset is also discussed.

6. **BCD Outputs (DMS-40PC-X-RS and -RL-BCD Models Only):** Models with a "-BCD" suffix have 12 extra output pins, labeled A through L (6 per side), that provide the following information: multiplexed serial BCD data, digit drive, and polarity indication. The data present on pins A - L simultaneously drives the meter's internal LED display. All functions on pins A - L are 5V CMOS compatible, however, they are only rated to drive one, 74LS series, TTL load. CMOS logic IC's, for example 74HC or 74HCT series devices, should be used when more fan-out capability is required.

   As the timing diagram in Figure 5 indicates, 100Hz is the optimum display scan rate when the BCD outputs are used to drive external LED displays. Faster scan rates, while permissible, are not necessary. Slower scanning, however, may result in noticeable "flickering" of the display. Common anode LED's, combined with a 74LS247 BCD to seven-segment decoder, is the simplest way of implementing an external display. A seventy-five to one-hundred Ohm resistor on each LS247 segment-drive output provides adequate display brightness.

The functions of pins A - L are listed below:

BCD DATA (pins I - L): Four lines are used for BCD (Binary Coded Decimal) data outputs, representing the numbers 0 - 9. Positive-logic convention (a high represents a "1") is used.

DIGIT DRIVE (pins A - E): These five outputs, when gated with STROBE, can be used to direct the BCD DATA into external latches. DIGIT DRIVE outputs may also be connected directly to the bases of NPN transistors in remote-display configurations. The digits are scanned right-to-left, i.e., MSD (DIGIT 1 DRIVE) to LSD (DIGIT 5 DRIVE).

BUSY (pin G): This is a status pin that goes high at the start of an analog-to-digital (A/D) conversion cycle and remains high until the conversion ends.

STROBE (pin H): A string of five sequential, active-low, STROBE pulses are output (after BUSY goes low) indicating the end of a conversion and the availability of new data. The 5 STROBE pulses occur only once per conversion, or 2.5 times each second. STROBE can be used to latch the BCD data (on pins I - L) into external latches. Either edge can be used since STROBE (~ 5µsec wide) is active only in the center of the corresponding DIGIT DRIVE and BCD DATA outputs.

POLARITY (pin F): This pin, which is also used inside the DMS-40PC to drive the negative-sign segment, indicates whether the last input signal conversion was positive (POLARITY set high) or negative (POLARITY set low). POLARITY, unlike BCD DATA, is not multiplexed. For data latching purposes, POLARITY should be sampled during the STROBE pulse for digit 1 (most significant digit).

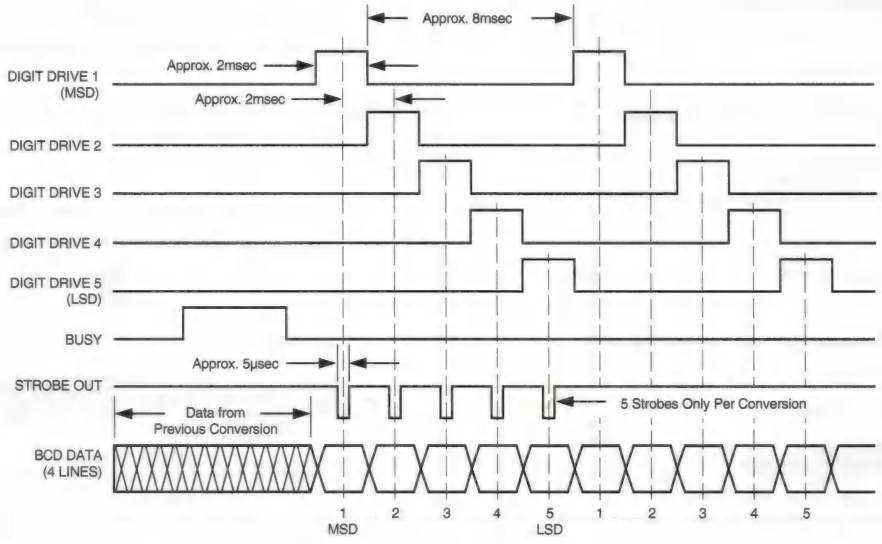
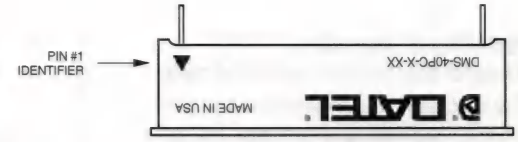


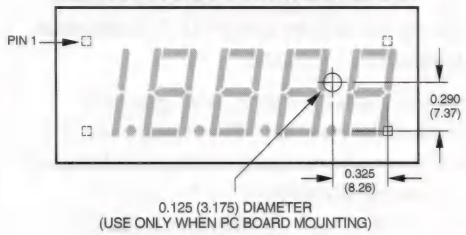
Figure 6. BCD Data Timing Diagram

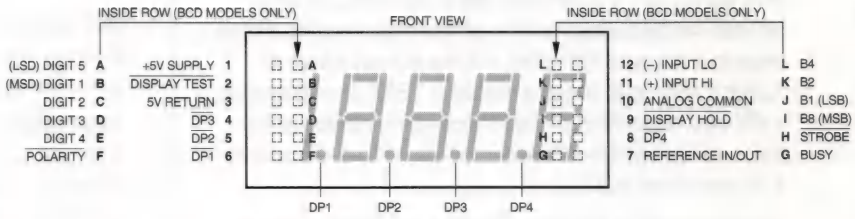
Mechanical Specifications

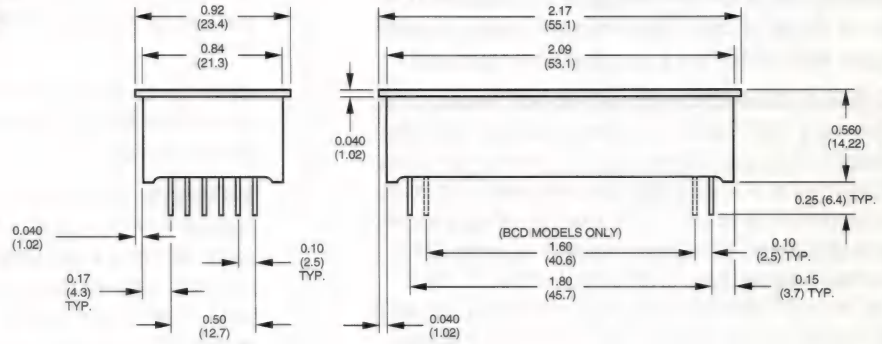
MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)



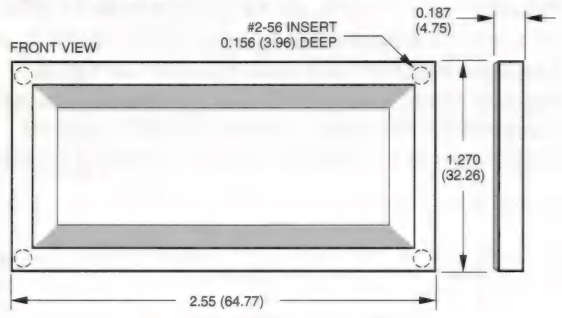
CALIBRATION POTENTIOMETER HOLE LOCATION



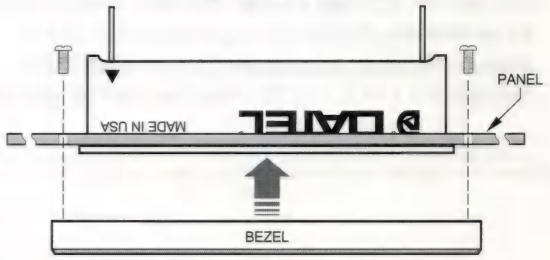




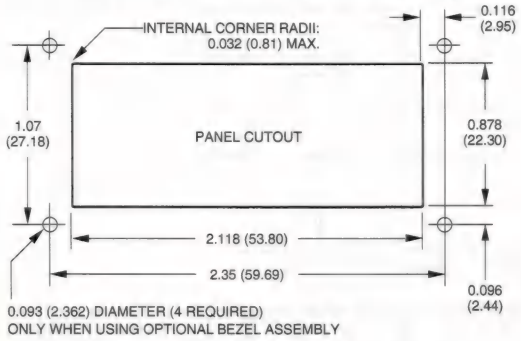
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



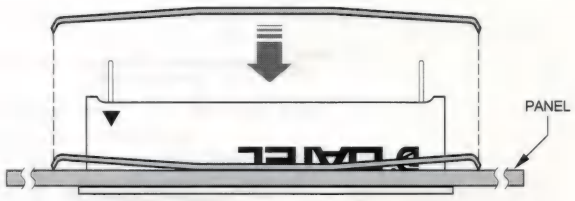
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



DS-0272 Rev. C

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Actual Size

DMS-40LCD Series

4½ Digit, LCD Display Low-Power, Miniature Digital Panel Voltmeters

Features

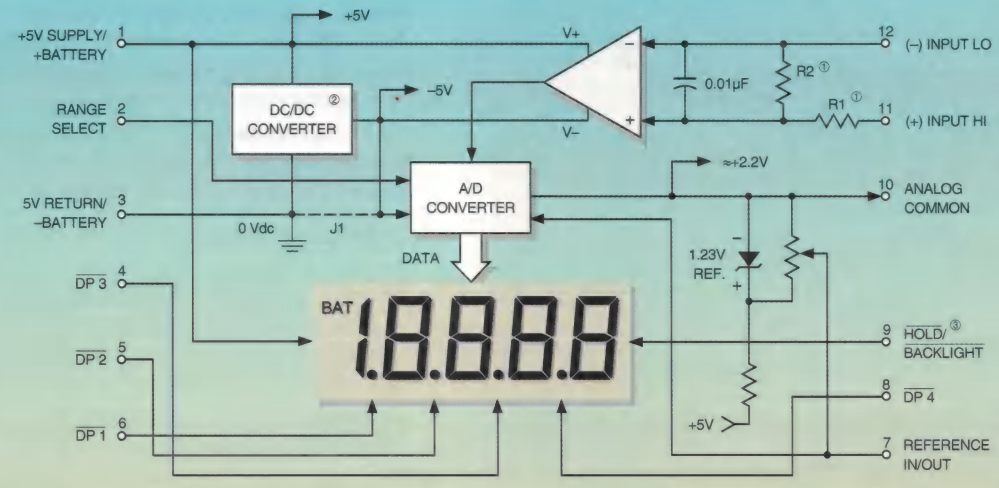
- Scientific-grade accuracy, ±2 counts
- Low power, typically 12.5mW
- Miniature size:
  2.17" x 0.92" x 0.43"
  55mm x 23mm x 11mm
- Large (0.4"/10.2mm), enhanced-contrast, LCD display
- Backlit displays optional
- Epoxy-encapsulated, 12-pin DIP
- Panel or pc-board mountable
- 3 differential, dual, input voltage ranges
- Single +5V supply or 9V battery
- User-selectable decimal point placement
- Low-battery "BAT" annunciator
- 0 to +50°C temperature range
- Low Cost

Offering a unique combination of low cost, scientific-grade accuracy (±2 counts), component-like convenience and outstanding reliability, DMS-40LCD Series 4½ Digit DPM's provide the ultimate combination of price, precision and convenience. These miniature (2.17" x 0.92" x 0.43") digital voltmeters combine an advanced, autozeroing A/D converter, a precision reference circuit and a large (0.4"/10.2mm high), easy-to-read LCD display in a single, fully encapsulated, 12-pin DIP package. All models incorporate a built-in bezel and are easily mounted in either panels or pc boards.

Each DMS-40LCD meter has a dual-range, differential, input configuration (±200mV/±2V, ±2V/±20V or ±20V/±200V) and is available with a backlit or non-backlit display. Input impedance is a minimum 800kΩ, and CMRR is typically 86dB (dc to 60Hz). CMV is ±2V, and all models are overvoltage protected to ±250V (on their non-inverting inputs).

All DMS-40LCD meters are fully functional and operate from a single +5V supply (drawing 3.5mA max.) or a single 9V supply/battery (drawing 2.5mA max.). All models feature autopolarity changeover and overrange indication. A display HOLD function is standard on all non-backlit models.

Thanks to their rugged epoxy-based encapsulation and their advanced, factory-calibrated A/D converters, DMS-40LCD meters are able to withstand the harshest environments and never require adjustment or calibration. Plug-in convenience, long-term stability and wide operating temperature range (0 to +50°C) make DMS-40LCD meters the right solution for any high-accuracy DPM requirement.



① R1 = 100k on ±200mV/±2V (-0/1) models and 909k on all other models.
R2 is not used on ±200mV/±2V (-0/1) models.
R2 = 101k on ±2V/±20V (-1/2) models and 9.2k on ±20V/±200V (-2/3) models.

② DC/DC converter is not used on 9V-powered models, J1 is connected.

③ Hold function is not available on backlit models.

Figure 1. DMS-40LCD Series Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C and supply voltage = +5V (using the single-ended input circuit) or +9V (using the differential input circuit), unless otherwise noted.

Analog Inputs	Min.	Typ.	Max.	Units
Full Scale Input Range: ①				
DMS-40LCD-0/1	--	±200/±2	--	mV/V
DMS-40LCD-1/2	--	±2/±20	--	V/V
DMS-40LCD-2/3	--	±20/±200	--	V/V
Input Impedance:				
DMS-40LCD-0/1	100	1000	--	MΩ
DMS-40LCD-1/2	0.8	1	--	MΩ
DMS-40LCD-2/3	0.8	1	--	MΩ
Overvoltage Protection ②	--	--	±250	Volts
Common Mode Voltage Range ③	--	--	±2	Volts
CMRR (dc to 60Hz)	--	86	--	dB
Control Inputs ④				
Decimal Point Placement (Pins 4-6, 8):				
Functionality	Tie to pin 3 to activate			
Logic Compatibility	TTL (on 5V-powered models)			
Hold/Backlight Functionality (Pin 9):				
Backlit Models	Tie to pin 3 to turn on backlight			
Non-backlit Models	Tie to pin 3 to hold last reading			
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (3 minute warm-up):				
DMS-40LCD-0/1 (V_{IN} = +0.19/1.9V)	--	±2	±3	Counts
DMS-40LCD-1/2 (V_{IN} = +1.9V)	--	±2	±3	Counts
DMS-40LCD-1/2 (V_{IN} = +19V)	--	±3	±4	Counts
DMS-40LCD-2/3 (V_{IN} = +19/190V)	--	±3	±4	Counts
Zero Reading (V_{IN} = 0 Volts)	"–0001"	"0000"	"0001"	
Temperature Drift (0 to +50°C):				
DMS-40LCD-0/1	--	±0.4	±0.8	Cnts/°C
DMS-40LCD-1/2	--	±0.6	±1	Cnts/°C
DMS-40LCD-2/3	--	±0.6	±1	Cnts/°C
Power Supply Requirements (5V Models)				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
Standard Models	--	+2.5	+3.5	mA
Backlit Models	--	+37	+45	mA
Power Supply Requirements (9V Models)				
Supply Voltage	+7.5	+9.0	+14.0	Volts
Supply Current:				
Standard Models	--	+1.5	+2.5	mA
Backlit Models	--	+37	+45	mA
Display				
Display Type and Size	4½ Digit LCD, 0.4"/10.2mm high			
Polarity Indication	Autopolarity ("–" for negative V_{IN})			
Overrange Indication	"–1____" for negative V_{IN} "1____" for positive V_{IN}			
Physical/Environmental				
Operating Temperature	0	--	+50	°C
Storage Temperature	–20	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.75 ounces (21 grams)			

① Each model in the DMS-40LCD Series offers two input voltage ranges that are user-selectable via pin strapping. 5V-powered models can be used to perform either differential or single-ended measurements. 9V-powered models can only be used for differential measurements.

② Applies for transient or continuous overvoltages applied to (+) INPUT HI (pin 11) with (–) INPUT LO (pin 12) properly connected. Pin 12 is not overvoltage protected (see Figure 1). Voltages applied to pin 12 should not exceed the supply voltage.

③ Listed spec applies to 5V-powered models only. For 9V-powered models, both (–) INPUT LO (pin 12) and (+) INPUT HIGH (pin 11) must always be at least 1.5V above –BATTERY (pin 3) and at least 1.5V below +BATTERY (pin 1).

④ See Technical Notes.

Ordering Information

DMS-40LCD - 0/1 - 5

Input Ranges:
0/1 = ±200mV/±2V
1/2 = ±2V/±20V
2/3 = ±20V/±200V

Leave blank for standard models.
Add **B** for backlit models.

Power Source:
5 = +5V
9 = +9V

Accessories:

DMS-30-CP	Panel cutout punch
DMS-BZL1	DMS-40 bezel assembly
DMS-BZL2	DMS-40 bezel assembly with sealing gasket
DMS-EB	Application/evaluation board with standard MOLEX connector, decimal point solder pads and attenuation resistor pads.

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **Input Voltage Range Selection:** Each model in the DMS-40LCD Series offers two, user-selectable, input voltage ranges as indicated in the Performance/Functional Specifications Table and the Ordering Information. To select the higher range of any device (such as the ±2V range for the DMS-40LCD-0/1), connect pin 2 (RANGE SELECT) to pin 1 (+5V SUPPLY/+BATTERY). To select the lower range, leave pin 2 open.
2. **Decimal Point Placement:** The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP4) are active low functions. Select the appropriate decimal point by tying the appropriate pin (pin 4, 5, 6 or 8) to pin 3 (5V RETURN/–BATTERY). Unused decimal point location pins should be left open. For 5V-powered models, the decimal location pins are TTL compatible and may be hard wired as described above or driven with 5V TTL logic gates.
3. **Low Battery Annunciator:** The "BAT" annunciator in the upper left-hand corner of the display turns on when the supply voltage for 5V-powered models falls below approximately +3.75V or when the supply voltage for 9V-powered models falls below approximately 7.2V. This function can not be disabled.

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4. **HOLD/BACKLIGHT (Pin 9) Function:** For non-backlit models, connecting pin 9 (HOLD/BACKLIGHT) to pin 3 (5V RETURN/ –BATTERY) will hold (continuously display) the last reading. If not used, pin 9 should be left open for these models.

   For backlit models, grounding pin 9 (i.e. connecting it to pin 3) turns on the backlighting LED's. 9V-powered backlit models function with supply voltages up to +14V, however, activating the backlight with voltages greater than 9.2V can damage the meter. Therefore, a 1/4 Watt series resistor must be installed between pins 3 and 9 in these situations. The value of the series resistor is determined using the following formula:

$$R_{Series} = \frac{+BATTERY - 9.2V}{0.035} \text{ Ohms}$$

   Example: If +BATTERY (pin 1 with respect to pin 3) is +12.6V,

$$R_{Series} = \frac{+12.6 - 9.2V}{0.035} \text{ Ohms}$$

$$R_{Series} = 97 \text{ Ohms}$$

   In any backlit application, including those with supply voltages < 9.2V, the current drawn by the backlight (and therefore the current drawn by the meter) can be reduced by installing a 1/4 Watt resistor between pins 3 and 9. The brightness of the backlight will be reduced proportionately.

5. **ANALOG COMMON (Pin 10):** This pin is connected to an internal, low-noise, "relative" ground. It is used in certain "floating" measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. **Pin 10 should not be connected to pin 3 (5V RETURN/–BATTERY) or to your system's analog ground.**

6. **REFERENCE IN/OUT (Pin 7):** This pin accesses the meter's internal reference and is used during the factory calibration procedure. Pin 7 should be left open in most common applications. It can be used in certain "ratiometric" applications in which it is desireable for the meter's reference to track an external reference. See the Applications section of the DATEL Panel Meter Catalog for more details.

7. **Gain Adjust:** There is a gain-adjust potentiometer on the back of each meter. It has approximately ±150 counts of adjustment range. Since these devices essentially have no zero/offset errors, a gain adjustment is effectively an overall accuracy adjustment. Though they may be performed at any point (except zero), accuracy adjustments are most effective when performed with higher level input signals.

8. **Soldering Methods:** All models in the DMS-40LCD Series easily withstand most common wave soldering operations. We recommend, however, you evaluate the effects your particular soldering techniques may have on the meter's plastic case and high-precision electrical performance. We recommend the use of water-soluble solders and thorough cleaning procedures.

9. **Suggested Mating Connectors:**

   Panel mounted:

Connector housing	DATEL P/N 39-2079400
Terminal type	DATEL P/N 39-2099090
Crimping tool	DATEL P/N 39-2099000
Wire size	22 to 26 AWG
Insulation diameter	0.062" (1.57mm) maximum
Stripping length	0.100 to 0.125" (2.54 to 3.17mm)

   Board mounted:

Socket	DATEL P/N 39-2359625

Applications

DMS-40LCD meters are available in either 5V-powered or 9V-powered models. 9V devices operate directly from 7.5V to 14V supplies (usually batteries) without the need for external voltage regulators. 9V devices, however, can not be used to measure voltages referenced to the negative battery terminal (pin 3) because the minus input to the meter (pin 12, (–) INPUT LO) must always be at least 1.5V above pin 3. 9V-powered meters can only be used to make differential and not single-ended measurements.

5V-powered devices operate from any well-regulated +5V supply and will accurately measure voltages both above and below pin 3 (5V RETURN) in either single-ended or differential configurations.

1. **Single-Ended Input Configurations:** True single-ended measurements can only be made with 5V-powered meters. The circuit of Figure 2 avoids problems normally associated with ground loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12).

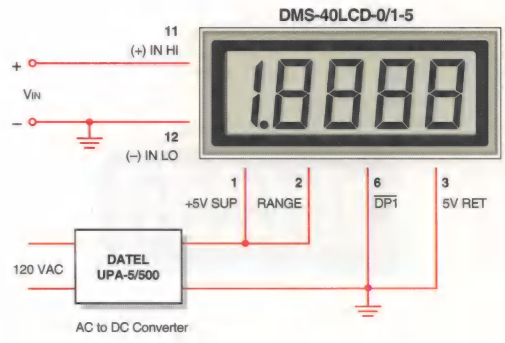

Figure 2. Single-Ended Input Configuration (5V-Powered Models)

Applications

2. **Differential Input Configurations:** Differential measurements can be made with either 5V-powered or 9V-powered meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V-powered meters.

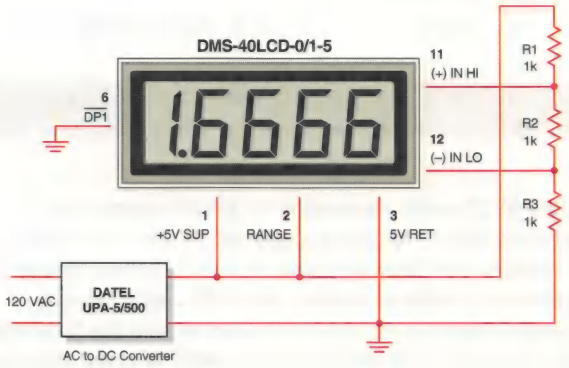

Figure 3. Differential Input Configuration (5V-Powered Models)

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal film resistors with absolute TCR's less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

$$50k\Omega < R1 + R2 < 10M\Omega$$

$$\frac{R2}{R1 + R2} \times V_{IN} = \text{Reading}$$

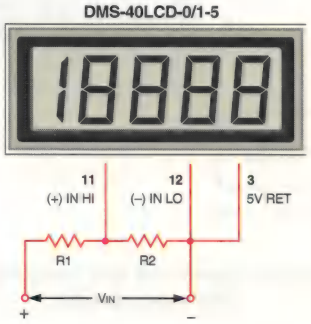

Figure 4. Input Attenuation Circuit

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6. Figure 5 uses a 5V-powered meter. Figure 6 uses a 9V-powered meter. Both figures show a DMS-40LCD-0/1 with pin 2 tied to pin 1 yielding a ±2V input range. Connecting pin 10 (ANALOG COMMON) to (–) INPUT LO (pin 12) provides the reference point for the meter's input.

A "floating" input is a signal that has no galvanic connection to the meter's power supply. In the figures below, the 1.5V battery illustrates a true floating input.

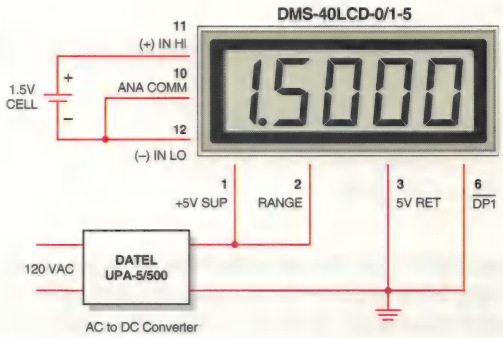

Figure 5. Floating Input Measurements (5V-Powered Models)

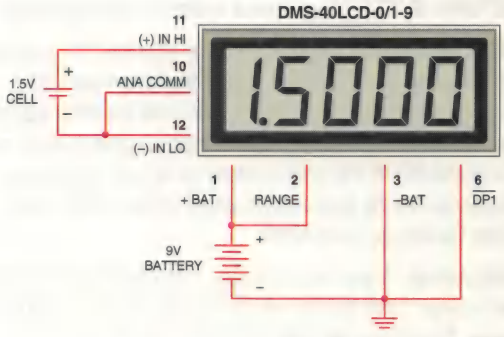

Figure 6. Floating Input Measurements (9V-Powered Models)

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Applications

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-40LCD meters have such high input impedance, a simple shunt resistor across the meter's input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a function of the scaling requirements of the particular application and can be calculated using the following equation:

$$R_{Shunt} = R1 = V_{Fsr} / I_{Fsr}$$

Where: V_{Fsr} = Full scale reading (in Volts)

I_{Fsr} = Relative full scale current (in Amps)

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired full scale display reading of 1000 (with an input of 20mA), V_{Fsr} = 1.000 Volts

R_{Shunt} = 1.000V/(0.020 – 0.004)A

R_{Shunt} = 1.000V/0.016A = 62.5 Ohms

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "0000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "19999". For different full scale readings, alter the value of R_{Shunt} accordingly.

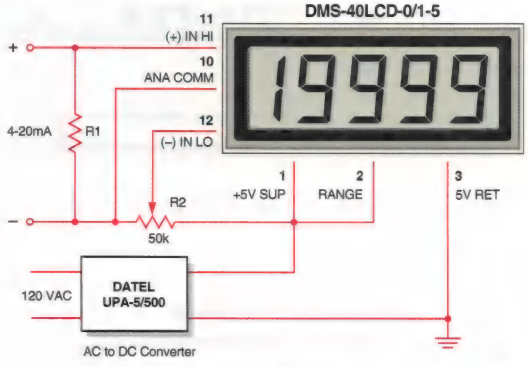


Figure 7. 4-to-20mA Current Loop Operation (5V-Powered Models)

6. **Power Supply Monitoring:** A popular application for DATEL's low-power LCD meters is monitoring the supply voltage in battery-operated portable equipment. Figure 8 demonstrates how a 9V-powered DMS-40LCD can be used to monitor its own supply. The meter used is the DMS-40LCD-0/1-9 configured for its ±2V input range (pin 2 connected to pin 1). A three-resistor voltage divider is used to attenuate the battery voltage and also to satisfy the requirement that the input voltages applied to pins 12 and 11 be at least 1.5 Volts above and below the battery voltage applied to pins 1 (+BATTERY) and 3 (–BATTERY). The divider should be designed so that 1/10th the battery voltage falls across the inputs to the meter.

$$\frac{R2}{(R1 + R2 + R3)} = 0.1$$

Therefore, the 9V battery voltage appears to the meter inputs as 0.9V. With the decimal point moved to its DP2 position (pin 5 tied to pin 3), the meter reads 9.000 Volts.

The circuit can be calibrated by first measuring the actual battery voltage with another meter and then adjusting the gain-adjust potentiometer on the back of the DMS-40LCD until a similar reading is obtained. If possible, the resistors in the divider should be ±1% metal-film types with TCR's less than 50ppm/°C.

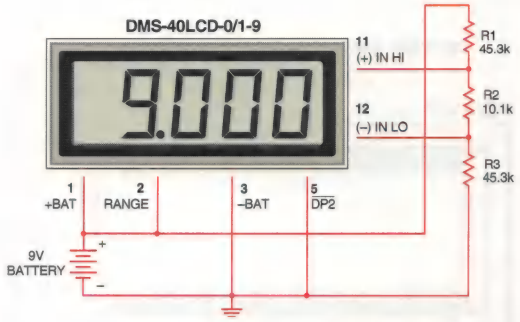
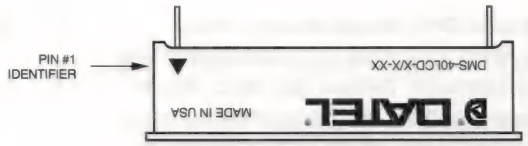
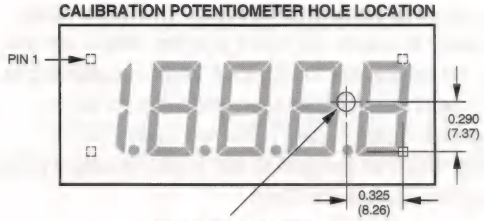


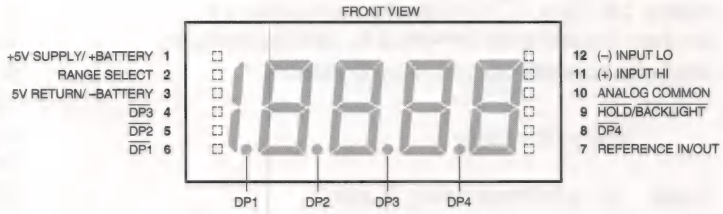
Figure 8. Power Supply Monitor (9V-Powered Models)

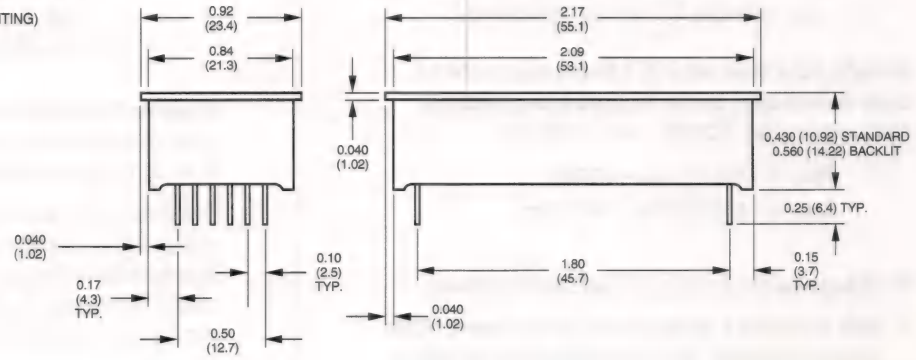
Mechanical Specifications

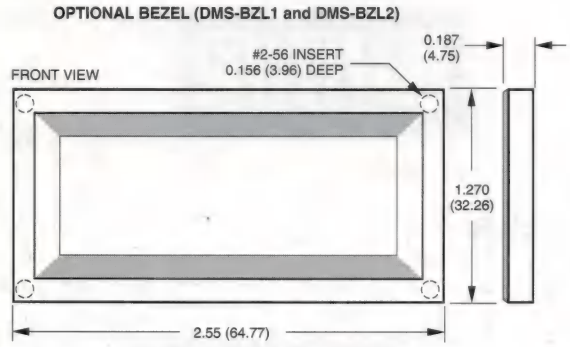
MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)

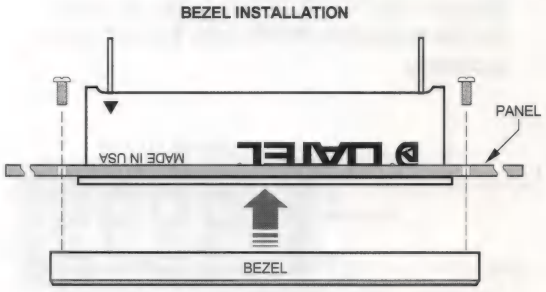


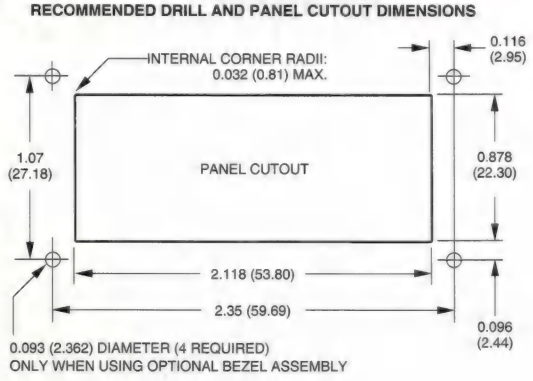


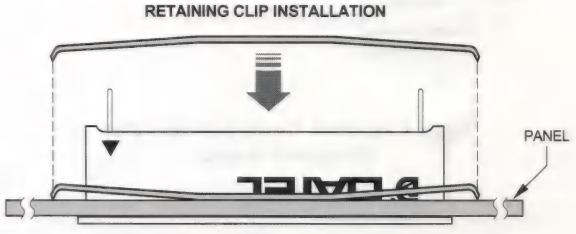












DS-0283 Rev. B

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DSD-40BCD Series

Miniature 4½ Digit, BCD Input Slave LED Display

Features

- Low cost! Complete! No external components required
- Rugged, epoxy-encapsulated package
- Ideal for computer-based instruments
- Miniature size: 2.17" x 0.92" x 0.56" 55mm x 23mm x 14mm
- Built-in color filter and bezel
- Single +5V supply, TTL compatible
- Low-power model, 35mA (175mW)
- Large (0.52"/13.2mm), matched-intensity, LED display
- Choice of red or green LED's
- Minus sign and decimal points included
- PC-board or panel mountable

DATEL's new DSD-40BCD digital slave display combines a full-size, 4½ digit, LED display with all the other necessary components (including a built-in, contrast-enhancing filter/bezel) to implement a pc-board mountable instrument display. The epoxy-encapsulated, 24-pin package, measuring only 2.17 x 0.92 x 0.56 inches, is perfectly sized to occupy the absolute minimum pc-board space. The one-piece LED display eliminates the need to purchase multiple, matched-intensity LED's — usually an expensive and limited-availability situation.

The DSD-40BCD's flexible design gives the user full control of all major display functions including display update rate, number of digits enabled, and decimal point selection. Its TTL-compatible inputs interface directly with most BCD output, integrating analog-to-digital converters — no additional glue logic is required! When used with sophisticated microcomputers, the brightness of any digit can be independently controlled by simply lowering the digit-drive input duty cycle.

The extremely rugged package allows all models to operate over the temperature range of 0 to +70°C (at 0 to 95% relative humidity). For power-sensitive designs, the low-power DSD-40BCD-RL model, with all digits turned on, draws only 35mA from its +5V supply. This ultra-low power consumption means that even battery-powered applications can now benefit from the superior readability offered by LED displays.

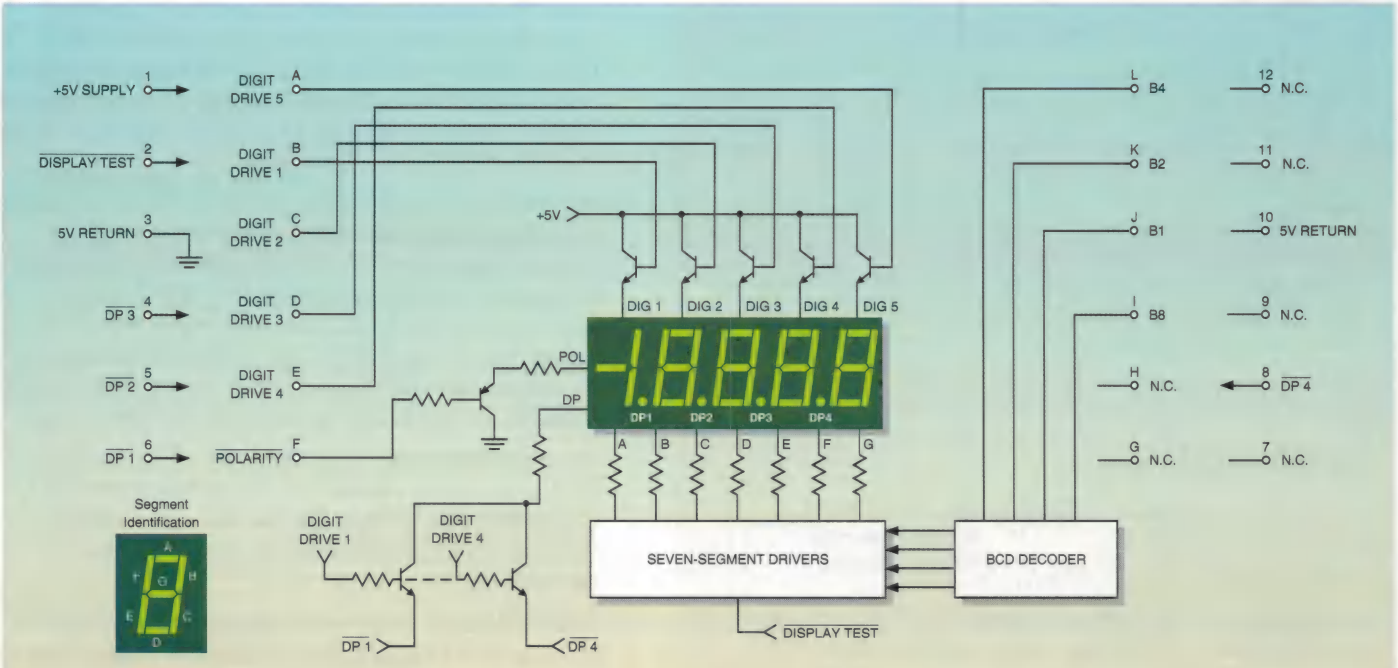

Figure 1. DSD-40BCD Series Simplified Schematic

Functional Specifications

T_A = +25°C and supply voltage = +5V, unless otherwise noted.

Control Inputs	Min.	Typ.	Max.	Units
BCD (pins I-L) **and TEST** (pin 2) **Inputs:**				
Low-Level Input Voltage (V_{IL})	--	--	+0.8	Volts
Low-Level Input Current (I_{IL})	--	--	0.4	mA
High-Level Input Voltage (V_{IH})	+2.4	--	--	Volts
High-Level Input Current (I_{IH})	--	--	0.05	mA
Polarity Input (pin F):				
Low-Level Input Voltage (V_{IL})	--	--	+0.8	Volts
Low-Level Input Current (I_{IL})	--	--	0.4	mA
High-Level Input Voltage (V_{IH})	+4.5	--	--	Volts
High-Level Input Current (I_{IH})	--	--	0.05	mA
Digit Drive Inputs (pins A-E):				
Low-Level Input Voltage (V_{IL})	--	--	+0.8	Volts
Low-Level Input Current (I_{IL})	--	--	0.4	mA
High-Level Input Voltage (V_{IH})	+4.5	--	--	Volts
High-Level Input Current (I_{IH})	--	--	2	mA
DP1-DP4 Inputs (pins 4-6, 8):				
Low-Level Input Voltage (V_{IL})	--	--	+0.8	Volts
Low-Level Input Current (I_{IL})	--	--	20	mA
High-Level Input Voltage (V_{IH})	+4.5	--	--	Volts
High-Level Input Current (I_{IH})	--	--	0.05	mA
Power Supply Requirements				
Supply Voltage	+4.75	+5.00	+5.25	Volts
Supply Current:				
DSD-40BCD-GS	--	+100	+130	mA
DSD-40BCD-RL	--	+35	+45	mA
DSD-40BCD-RS	--	+85	+110	mA
Display				
Display Type and Size	4½ Digit LED, 0.52"/13.2mm high			
LED Peak Wavelength (λ):				
DSD-40BCD-GS	--	565	--	nm
DSD-40BCD-RL	--	660	--	nm
DSD-40BCD-RS	--	635	--	nm
Physical/Environmental				
Operating Temperature	0	--	+70	°C
Storage Temperature	–40	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	1 ounce (28 grams)			

BCD Inputs and Resultant Displays

0000 0001 0010 0011 0100 0101 0110 0111 1000 1001 1010 1011 1100 1101 1110 1111

Ordering Information

DSD-40BCD - R S

LED Color: GS = Standard Green
RL = Low-Power Red
RS = Standard Red

Accessories:

DMS-30-CP	Panel cutout punch
DMS-BZL1	DSD-40 bezel assembly
DMS-BZL2	DSD-40 bezel assembly with sealing gasket

A panel-mount retaining clip is supplied with each model.

Technical Notes

1. **DSD-40BCD Operation** (Please Refer to the Timing and Pinout Diagrams for the Following Discussion): The DSD-40BCD display has five digits, labeled digit 1 (left-most digit or MSD) through digit 5 (right-most digit or LSD), which are turned on by bringing their respective DIGIT DRIVE inputs to a high logic level. The binary coded decimal data (BCD) on pins I-L is decoded into the corresponding seven-segment LED outputs necessary to display the numerals "0" through "9".

   Since there are effectively five digits and only one set of BCD data inputs, the DSD-40BCD's digits have their segments tied ("multiplexed") together. The top segment, referred to as segment A, of digit 5 is connected to the A segment of the other three digits (digit 1 has no A segment). The remaining B, C, D, E, F and G segments are connected to each other in the same fashion.

   As an example of how the multiplexing scheme works, assume that the BCD data inputs are 0001 (the BCD code for the decimal number 1) and also assume that the DIGIT DRIVE 3 input is high. Under these conditions, the B and C segments of digits 1-5 will all be enabled. However, only the digits whose DIGIT DRIVE inputs are high, in this case only digit 3, will display the numeral "1". All the other digits will be off. This example, while technically valid, will produce an extremely bright "1" for digit 3. This will be explained in greater detail in the section titled "Controlling the Display Brightness."

2. **DSD-40BCD Timing Diagram** (See Figure 2): The timing diagram depicts the required typical input conditions and timing relationships that allow the user to access all 5 digits. The recommended display scan rate is 100Hz. All 5 digits are scanned in 10ms, and each individual digit is "on" for 2ms (20% duty cycle). The 100Hz figure is not critical; it can go as low as 70Hz without any impact on display visibility.

   The timing diagram shows the digits being scanned from left to right (DIGIT 1 to DIGIT 5), but this order is not mandatory. Any drive sequence can be used, as long as BCD data is presented at the correct corresponding DIGIT DRIVE interval. **An important point to keep in mind is that the DSD-40BCD has no internal data latches!** The DIGIT DRIVE and BCD data inputs must be continuously strobed to keep the display properly illuminated.

3. **Decimal Point Inputs ($\overline{DP1}$-$\overline{DP4}$, Pins 4-6, 8):** The four, active-low, decimal point segments are multiplexed in a similar, though not identical, manner as the rest of the digit segments. The four decimal points are controlled by their respective DIGIT DRIVE inputs. A selected decimal point may be permanently connected to ground. It will only be illuminated when its respective DIGIT DRIVE input is high. For example, if pin 6 ($\overline{DP1}$) is hard-wired to pin 3 (5V RETURN), DP1 will only be on during the time interval that DIGIT DRIVE 1 is high.

   As the specifications table clearly states, $\overline{DP1}$-$\overline{DP4}$ each require 20mA of sink current in order to achieve good illumination levels. Unused decimal points may be left open. The specified minimum V_{IH} applies only if logic-level devices are used to select the decimal points.

4. **$\overline{POLARITY}$ (Pin F):** The function of this active-low pin is to turn on the minus sign if negative readings are desired. The polarity input, like the decimal points, can also be permanently connected to ground. However, $\overline{POLARITY}$ is logic-level compatible and does not require

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the high sink currents that $\overline{DP1}$ - $\overline{DP4}$ do. If negative readings are never displayed, the $\overline{POLARITY}$ input may be left open.

5. **Controlling Display Brightness:** The LED current-setting components inside the DSD-40BCD are selected to produce good display brightness — while keeping power dissipation at reasonable levels — with a 20% duty cycle. Since no data latches are utilized in the DSD-40BCD design, the user can exercise full control over how many digits are enabled, and their relative brightness, by manipulating the duty cycle of the DIGIT DRIVE input.

   To turn off one digit, for a four digit application, simply leave the respective DIGIT DRIVE input (DIGIT DRIVE 5 in this example) open or low. If the timing relationships remain unchanged (i.e., 20% duty cycle), the display brightness will remain the same as when all five digits are used. However, if the duty cycle is changed to 25% (because only four digits are used), the increase in display intensity will be noticeable. In most applications, this increase in intensity will not be significant enough to justify any timing changes.

6. **Highlighting Selected Digits:** In many instrument designs, it is sometimes desirable to highlight or "flash" one particular digit to draw the user's attention to that digit. Once again, duty cycle control of the digit drive inputs makes this a relatively simple task. The easiest way is to flash the digit on and off, at a 0.5 to 1Hz rate, with the DIGIT DRIVE input. Keeping the duty cycle fixed at 20% for 5-digit applications, and 25% for 4-digits, will keep the intensity of the non-flashed digits uniform.

7. **Power Supply Decoupling:** The DSD-40BCD is not sensitive to logic noise or spikes, on either the 5V supply or the data inputs, because it does not use any edge-triggered logic. However, it does generate a fair amount of switching transients due to the display's multiplexed architecture. A tantalum electrolytic capacitor, in the range of 15 to 22µF, in parallel with a 0.1µF ceramic capacitor will reduce the LED switching transients. These two capacitors should be located as close as possible to pins 1 and 3.

8. **Interfacing BCD-Output A/D Converters:** The DSD-40BCD accepts the BCD data from DATEL's DMS-40PC-X-RS-BCD Series, 4½ Digit Panel Meters. DMS-40PC meters are exactly the same size as the DSD-40BCD display making it ideal for use in remote-display applications.

   The DSD-40BCD will also interface directly with the ICL7135, 4½ digit, integrating A/D converter's BCD and DIGIT DRIVE outputs. The only difference is that the ICL7135 has its five DIGIT DRIVE outputs labeled in a right-to-left order, i.e., the 7135's MSD is labeled digit 5 and its LSD is labeled digit 1. This is opposite to the DSD-40BCD labeling its MSD digit 1 and its LSD digit 5. Please refer to the 7135's data sheet for more information.

9. **$\overline{DISPLAY\ TEST}$ (Pin 2):** The DSD-40BCD's display can have all its segments enabled by bringing $\overline{DISPLAY\ TEST}$ low. The display will show "–18888" (excluding the decimal points) as long as the digit drive inputs are continuously strobed.

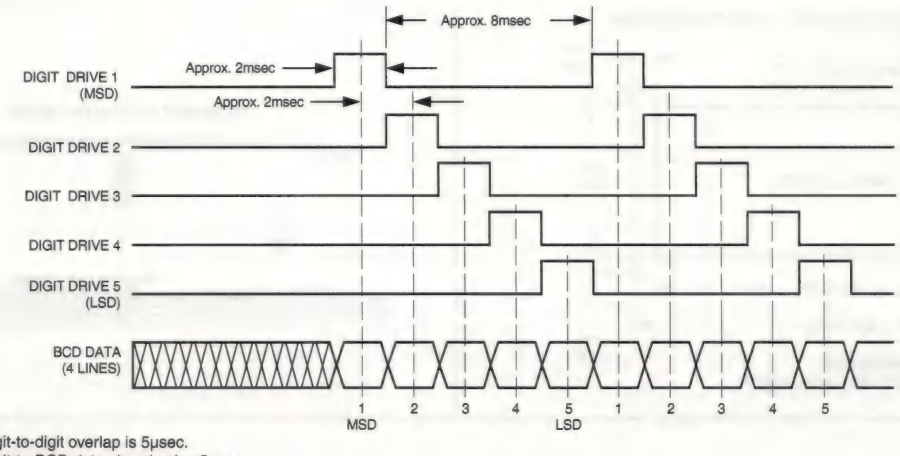
10. **Soldering Methods:** DSD-40BCD Series displays easily withstand most common manual and wave soldering operations. However, we highly recommend that you evaluate the effects your particular soldering techniques may have on the display's polycarbonate case and overall performance. We also recommend the use of no-clean solders since their residue normally has no detrimental effects on low-speed digital devices.

11. **Suggested Mating Connectors:**

    Board mounted:
    Socket DATEL P/N 39-2359624

    Panel mounted:
    DATEL recommends the use of IDC (insulation displacement) connectors when panel mounting the DSD-40BCD. SAMTEC's HCS series of IDC cable strips can be ordered in a variety of lengths and connector terminations. Please contact SAMTEC, Inc. at:

USA (Indiana)	812-944-6733	Fax: 812-948-5047
Europe (Scotland)	01236-739292	Fax: 01236-727113
Asia (Singapore)	65-745-5955	Fax: 65-841-1502

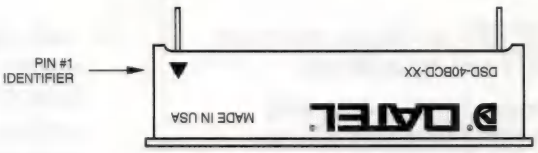


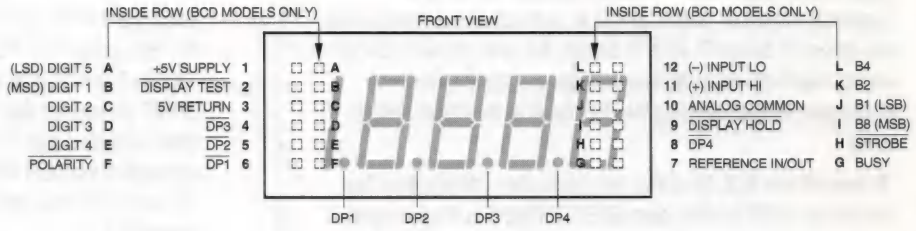
Notes:
1. Maximum allowable digit-to-digit overlap is 5µsec.
2. Maximum allowable digit-to-BCD data skew is also 5µsec.

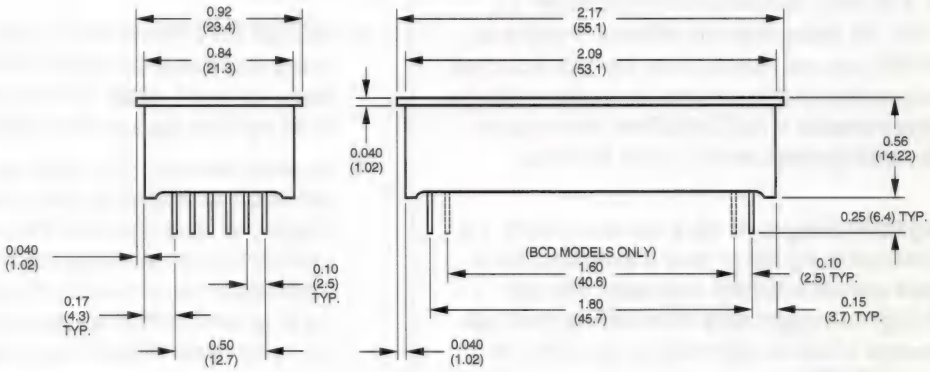
Figure 2. BCD Data Timing Diagram

Mechanical Specifications

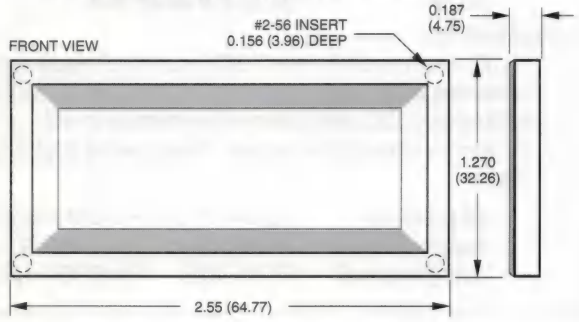
MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PC BOARD FINISHED HOLE DIAMETER:
0.042 ±0.003 (1.067 ±0.076)



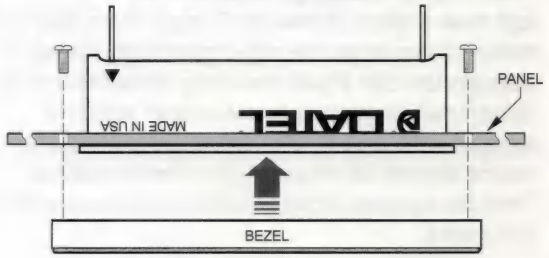




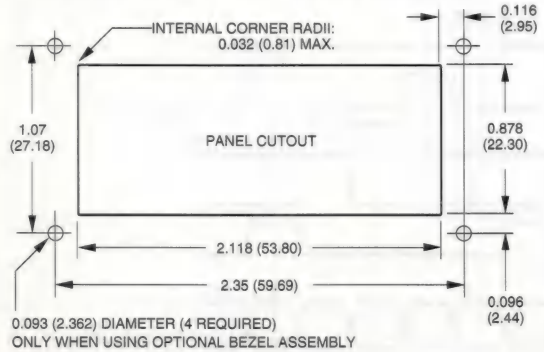
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



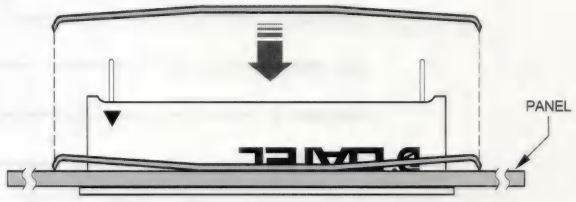
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



DS-0335 Rev. A

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
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2-Wire Digital Meters

Power your measuring instrument with the signal you're measuring! Simply make two connections (the + and – leads of your input signal) and your new DATEL "self-powered" meter is fully operational – with absolutely no external components or auxiliary power supplies required.

DATEL's uniquely experienced design-engineering team has taken our industry-leading miniature (DMS-30 Series) and subminiature (DMS-20 Series) digital panel meters and configured them for application-specific, 2-wire operation.

Perform dozens of everyday measurements easier than you ever thought possible. Measure the voltage at a standard USA-style wall outlet simply by "plugging in" an ac line monitor. Scrutinize the critical 3.3V of a CPU power supply with a 10mV-accurate, 2-wire meter that draws a mere 80mA. Monitor the 400Hz frequency of an aircraft power generator without worrying about "proper" grounding.

Measurement devices easier-to-use than these do not exist!

3

Table of Contents

Selection Guide 3-2

AC Voltmeters

DMS-20PC-1-LM	85-264Vac, 3 Digit LED Display	3-3
DMS-20PC-2-LM	85-140Vac/240-310Vac, 3 Digit LED Display	3-4
DMS-20PC-3-LM	350-600Vac, 3 Digit LED Display	3-5

AC Frequency Meters

DMS-20PC-1/2/3-FM	47-99Hz/350-450Hz, 3 Digit LED Displays	3-6

DC Voltmeters

DMS-20LCD-0/1-DCM	6.5-40Vdc (2 Ranges), 3½ Digit LCD Displays	3-7
DMS-20PC-0/1/2-DCM	4.5-264Vdc (3 Ranges), 3½ Digit LED Displays	3-8
DMS-20PC-3-DCM	2-6Vdc, 3 Digit LED Display	3-9
DMS-20PC-4/5/6-DCM	–4.5 to –264Vdc (3 Ranges), 3½ Digit LED Displays	3-10
DMS-20PC-7-DCM	–36 to –75Vdc, 3 Digit LED Display	3-11

DATEL
INNOVATION and EXCELLENCE

Selection Guide

2-Wire Meters

Input Range	Display Type and Resolution	DATEL Model Number	Features	Page
AC Voltmeters				
85-264Vac @ 47-63Hz	3 Digit Red LED	DMS-20PC-1-LM	"F" model plugs directly into USA wall outlets	3-3
85-140Vac @ 350-450Hz 240-310Vac @ 47-99Hz	3 Digit Red LED	DMS-20PC-2-LM	One device covers two operating ranges	3-4
350-600Vac @ 47-63Hz	3 Digit Red LED	DMS-20PC-3-LM	For 480Vac 3-phase primary power	3-5
AC Frequency Meters				
47.0-99.0Hz @ 85-140Vac	3 Digit Red LED	DMS-20PC-1-FM	The smallest ac frequency meters	3-6
47.0-99.0Hz @170-264Vac	3 Digit Red LED	DMS-20PC-3-FM	For 220Vac applications	3-6
350-450Hz @ 85-140Vac	3 Digit Red LED	DMS-20PC-2-FM	For aircraft and other 400Hz applications	3-6
DC Voltmeters				
+2.00 to +6.00Vdc	3 Digit Red LED	DMS-20PC-3-DCM	Bright red LED's, 80mA max. current at 3.3V	3-9
+4.50 to +19.99Vdc	3½ Digit Red LED	DMS-20PC-0-DCM	Bright red LED's, 13mA max. current	3-8
+6.50 to +18.00Vdc	3½ Digit LCD	DMS-20LCD-0-DCM	The lowest-cost 2-wire meters	3-7
+8.0 to +40.0Vdc	3 Digit LCD	DMS-20LCD-1-DCM	The lowest-cost 2-wire meters	3-7
+18.0 to +50.0Vdc	3 Digit Red LED	DMS-20PC-1-DCM	Reverse polarity protected, 13mA max. current	3-8
+30 to +264Vdc	3 Digit Red LED	DMS-20PC-2-DCM	Reverse polarity protected, 7mA max. current	3-8
–4.50 to –19.99Vdc	3½ Digit Red LED	DMS-20PC-4-DCM	Bright red LED's, 13mA max. current	3-10
–18.0 to –50.0Vdc	3 Digit Red LED	DMS-20PC-5-DCM	Reverse polarity protected, 13mA max. current	3-10
–30 to –264Vdc	3 Digit Red LED	DMS-20PC-6-DCM	Reverse polarity protected, 7mA max. current	3-10
–36.0 to –75.0Vdc	3 Digit Red LED	DMS-20PC-7-DCM	Great for monitoring -48V power buses	3-11

Simplifying digital panel meters

The deceptively "low-tech" digital panel meter (DPM) has been a challenging—and sometimes outright confusing—device to install and operate . . . *until now.*

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
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DATEL
INNOVATION and EXCELLENCE

Actual Size

DMS-20PC-1-LM

Self-Powered, 3 Digit, LED AC Line Voltage Monitors

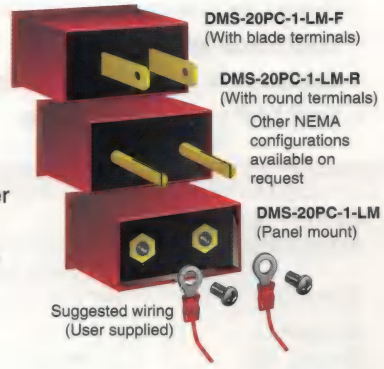
Features

- **Plugs directly into USA-style wall outlets**
- **Screw terminals for panel mounting**
- **Small 1.38" x 0.88" x 1.0" packages**
- **Large, easy-to-read, red LED displays**
- **Fully encapsulated for harsh environments**
- **Half-wave averaging, rms calibrated**
- **UL, CSA and IEC1010-1 certified**
- **Very low cost!**

DATEL's DMS-20PC-1-LM is a component-size, self-contained, low-cost ac voltmeter for true line measurements. It requires no additional components or auxiliary power. Simply plug it into any wall outlet and instantly read voltages from 85 to 264Vac (47-63Hz). The large (0.37"/9.4mm), bright red LED display makes the DMS-20PC-1-LM easily readable under any lighting conditions.

DMS-20PC-1-LM employs half-wave sinusoidal averaging (rms calibrated) and has a display resolution of 1Vac over its full input range. Packaged in a red-filter case with built-in bezel, the meter is fully encapsulated for ruggedness. All units are overvoltage protected to 300Vac.

This low-cost meter is ideal for industrial, laboratory, office and field-service applications. Its miniature size is perfect for design into high-end consumer electronics, laboratory instrumentation and other products requiring accurate ac line monitoring.



Functional Specifications

Input	
Voltage Range ①	85-264Vrms
Overvoltage Protection	300Vrms (Overvoltage category II)
Frequency Range ①	47-63Hz
Current Consumption	50mArms (max.)
Performance	
Sampling Rate	2.5 readings/second
Measurement Type	Half-wave average, rms calibrated for sinusoidal input
Accuracy @ +25°C	±1V (typ.), ±2V (max.)
Temperature Drift (–25 to +60°C)	±0.15 Volts/°C (max.)
Mechanical	
Dimensions	1.38" x 0.88" x 1.00"
DisplayType	3 digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate
Environmental	
Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below these ranges are not specified.

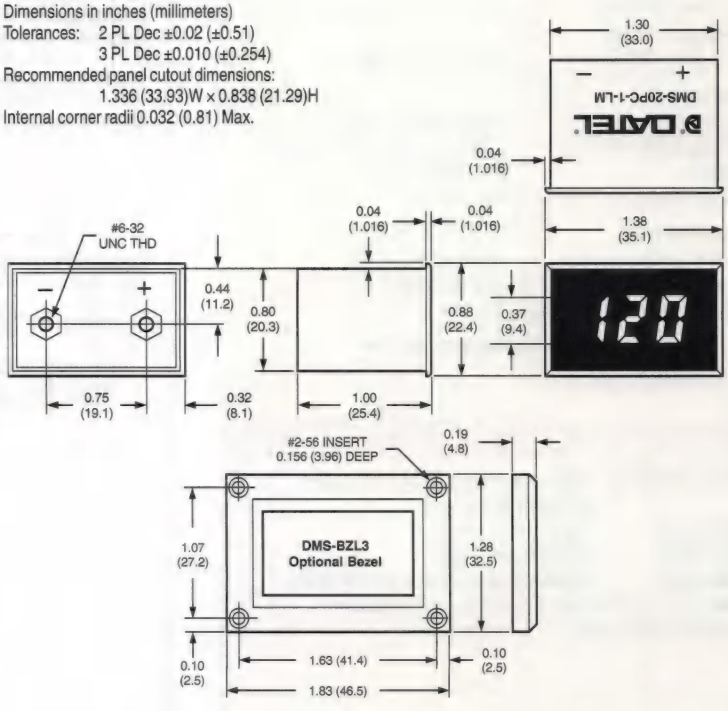
Ordering Information

DMS-20PC-1-LM	With threaded terminations and screws
DMS-20PC-1-LM-F	With blade terminals, factory installed
DMS-20PC-1-LM-R	With round terminals, factory installed
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0281 Rev. A

3

DATEL
INNOVATION and EXCELLENCE

Actual Size

DMS-20PC-2-LM

Self-Powered, LED Display High-Voltage, 60/400Hz, AC Monitor

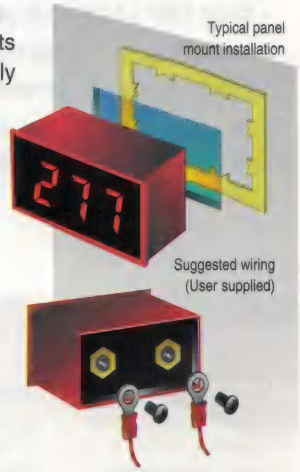
Features

- **Self-powered, two-terminal operation**
- **Dual operating ranges: 240-310Vac at 50/60Hz or 85-140Vac at 400Hz**
- **Half-wave averaging, rms calibrated**
- **Large, easy-to-read, bright red LED display**
- **Rugged, epoxy-encapsulated construction**
- **Built-in bezel for panel mounting**
- **Reliable screw terminals for easy installation**
- **Small 1.38" x 0.88" x 1.0" package**

DATEL's DMS-20PC-2-LM is a component-size, self-contained, low-cost ac voltmeter specifically designed for high-voltage *or* high-frequency operation. The DMS-20PC-2-LM's unique power-supply circuitry allows a single model to operate from *either* 240 to 310Vac with 50/60Hz inputs or from 85 to 140Vac with 400Hz inputs. The meter requires no external components or auxiliary power for full operation! Its large, 0.37"/9.4mm, bright red LED display is easily readable under virtually all lighting conditions.

DMS-20PC-2-LM employs half-wave sinusoidal averaging (rms calibrated) to achieve a display resolution of 1Vac over its full operating range. Packaged in a red-filter case with a built-in bezel, the meter is epoxy encapsulated for ruggedness.

This low-cost, extremely versatile digital voltmeter is ideal for use in emergency power equipment, 277Vac fluorescent lighting systems, 400Hz aircraft installations, and any other application requiring accurate, high-voltage or high-frequency, ac line monitoring.



Functional Specifications

Input	
Voltage Ranges: ①	240-310Vrms (47-99Hz) 85-140Vrms (350-450Hz)
Current Consumption	50mArms (max.)
Performance	
Sampling Rate	2.5 readings/second
Measurement Type	Half-wave average, rms calibrated for sinusoidal input
Accuracy @ +25°C	±1V (typ.), ±2V (max.)
Temperature Drift (–25 to +60°C)	±0.15 Volts°C (max.)
Mechanical	
Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate
Environmental	
Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below these ranges are not specified.

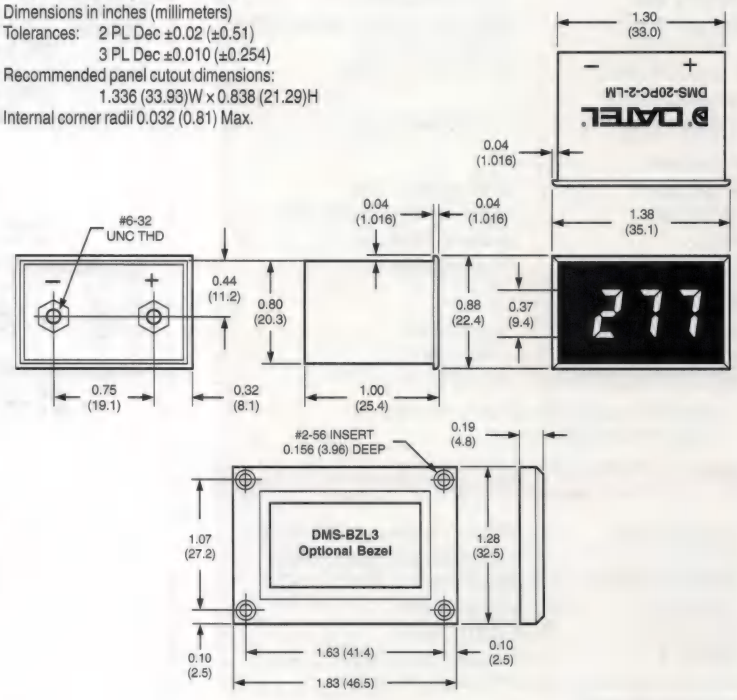
Ordering Information

DMS-20PC-2-LM	High-voltage ac monitor with screw terminals and screws
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0389 Rev. A

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com

Actual Size

DMS-20PC-3-LM

Self-Powered, LED Display 480V AC Line Monitor

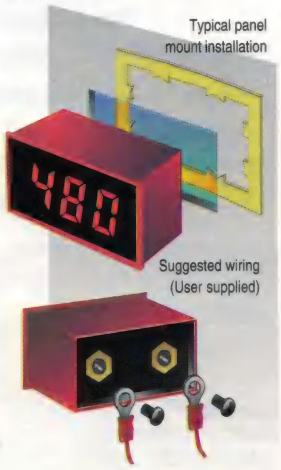
Features

- **Self-powered, two-terminal operation**
- **350 to 600Vac operating input range**
- **Half-wave averaging, rms calibrated**
- **Large, easy-to-read, bright red LED display**
- **Rugged, epoxy-encapsulated construction**
- **Built-in bezel for panel mounting**
- **Reliable screw terminals for easy installation**
- **Small 1.38" x 0.88" x 1.0" package**

DATEL's DMS-20PC-3-LM is a low-cost, self-powered, 2-wire digital voltmeter designed for monitoring 480Vac 3-phase primary power. The DMS-20PC-3-LM's unique power-supply design allows a single model to operate from 350 to 600Vac (47-63Hz). The meter requires no external components or auxiliary power for full operation! Its large, 0.37"/9.4mm, bright red LED display is easily readable under virtually all lighting conditions.

DMS-20PC-3-LM employs rms calibrated, half-wave sinusoidal averaging to achieve a display resolution of 1Vac over its full operating range. Packaged in a subminiature (1.38" x 0.88" x 1.0") red-filter case with a built-in bezel, the meter is epoxy encapsulated for ruggedness. An optional bezel assembly, featuring metal fasteners, simplifies panel mounting.

This easy-to-use, vibration-proof voltmeter is the ideal digital upgrade for fragile analog-style panel meters in 480Vac power distribution equipment. It similarly excels in any new application requiring accurate, high-voltage, ac line monitoring.



Functional Specifications

Input	
Voltage Range ①	350-600Vrms (47-63Hz)
Current Consumption	50mArms (max.)
Performance	
Sampling Rate	2.5 readings/second
Measurement Type	Half-wave average, rms calibrated for sinusoidal input
Accuracy @ +25°C	±1V (typ.), ±2V (max.)
Temperature Drift (–25 to +60°C)	±0.15 Volts/°C (max.)
Mechanical	
Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate
Environmental	
Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below this range are not specified.

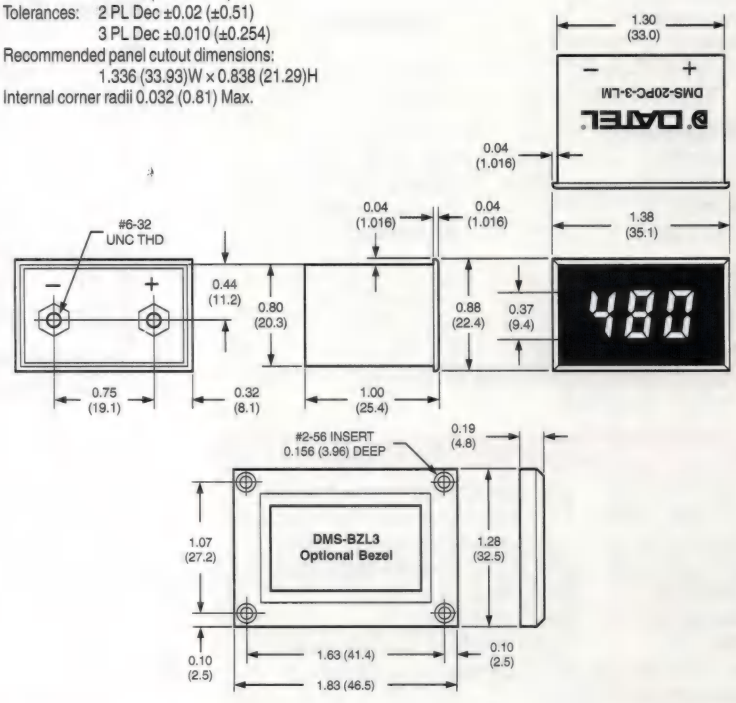
Ordering Information

DMS-20PC-3-LM	350-600Vac line monitor with screw terminals and screws
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0388 Rev. A

3

DATEL
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Actual Size

DMS-20PC-FM

Self-Powered, 3-Digit, LED AC Line Frequency Monitors

Features

- **Self-powered, no external supplies required**
- **3 models: 47.0-99.0Hz (85-140Vac)**
  47.0-99.0Hz (170-264Vac)
  350-450Hz (85-140Vac)
- **Screw terminals simplify panel mounting**
- **Ideal for emergency power equipment**
- **Small 1.38" x 0.88" x 1.0" packages**
- **Epoxy encapsulated for harsh environments**
- **Large (0.40"/10.2mm) red LED displays**

Functional Specifications

Input

Freq. Range (Voltage Range): ①	
DMS-20PC-1-FM	47.0-99.0Hz (85-140Vac)
DMS-20PC-2-FM	350-450Hz (85-140Vac)
DMS-20PC-3-FM	47.0-99.0Hz (170-264Vac)
Current Consumption	50mArms (max.)
Overvoltage Protection:	
DMS-20PC-1/2-FM	200Vrms (max.)
DMS-20PC-3-FM	300Vrms (max.)

Performance

Sampling Rate	4 readings/second
Accuracy (–25 to +60°C):	
DMS-20PC-1/3-FM	±0.1Hz
DMS-20PC-2-FM	±1.0Hz

Mechanical

Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 digit, red LED, 0.4"/10.2mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate

Environmental

Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below these ranges are not specified.

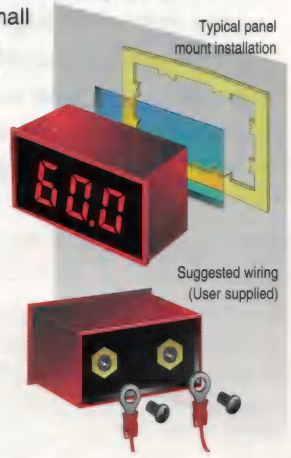
Ordering Information

DMS-20PC-1-FM	47.0-99.0Hz/120Vac frequency monitor
DMS-20PC-1-FM-F	"-1" models with blade terminals (see pg. 3-3)
DMS-20PC-2-FM	350-450Hz/120Vac frequency monitor
DMS-20PC-3-FM	47.0-99.0Hz/220Vac frequency monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

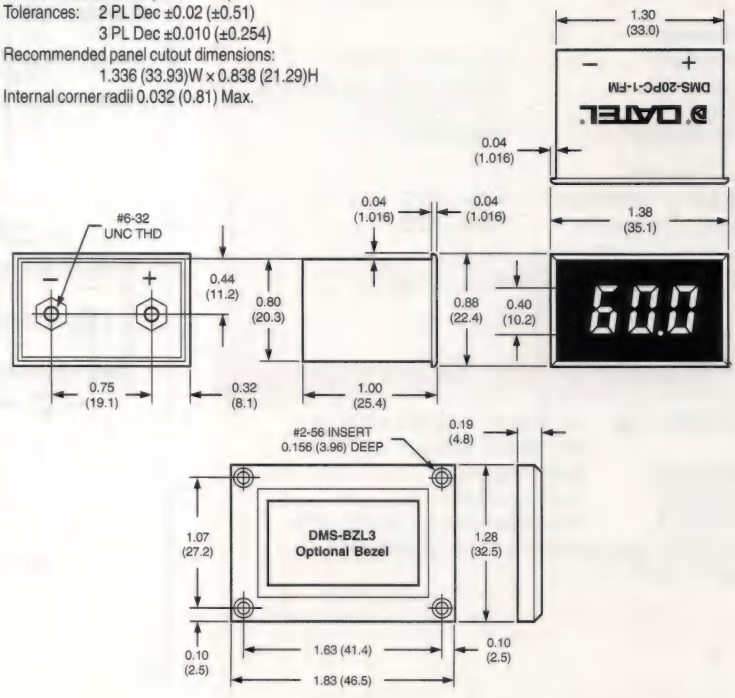
DATEL's new DMS-20PC-FM Series are the world's smallest, self-powered, ac frequency meters. Simply connect the ac line to the two rear input terminals, and the unit is fully operational with no additional components or auxiliary power required! Two, 50/60Hz models operate over input voltage ranges of 85-140Vac or 170-264Vac. A third, 400Hz model operates over an input voltage range of 85-140Vac. Despite their small size (1.38" x 0.88" x 1.0"), DMS-20PC-FM meters feature large 0.40"/10.2mm red LED's that can be easily read from 15 feet away.

An ultra-stable, quartz-crystal-controlled, embedded microcomputer provides accuracies of ±0.1Hz (50/60Hz models) or ±1.0Hz (400Hz model) over the entire operating temperature range of –25 to +60°C. Epoxy encapsulated plastic packages provide excellent protection against the harsh environments normally encountered by emergency backup power generators. DMS-20PC-FM meters are the exact same size as DATEL's popular AC Line Voltage Monitors (models DMS-20PC-X-LM).



Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0387 Rev. A

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Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com

Actual Size

DMS-20LCD-0/1-DCM

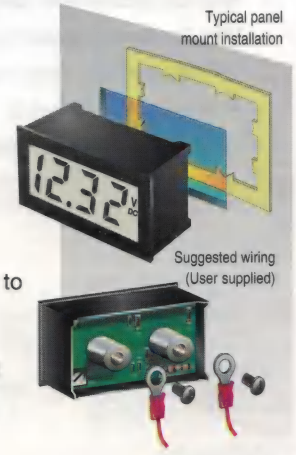
Self-Powered, LCD Display Digital, DC Voltage Monitors

Features

- **Self-powered, only two connections required**
- **+6.50-18.00Vdc (0.01V resolution) or +8.0-40.0Vdc (0.1V resolution) input ranges**
- **Ideal for battery-powered systems**
- **Reverse polarity protected**
- **Built-in "VDC" annunciator**
- **Large (0.37"/9.4mm) LCD displays**
- **Subminiature 1.38" x 0.88" x 0.66" packages**
- **Rugged, ABS package**

DATEL's new DMS-20LCD-DCM, self-contained, self-powered, dc voltage monitors set new standards for quality, performance, size and cost. Simply apply power to the two rear terminals and the unit is operational. No additional components are required! The large, 0.37"/9.4mm, LCD display, with built-in "VDC" annunciator, can be easily read from 10 feet. Two models are available: one for 12Vdc nominal operation (+6.50-18.00V range, 0.01V resolution), the other for 24Vdc nominal operation (+8.0-40.0V range, 0.1V resolution). Reverse polarity protection is standard on both models.

The DMS-20LCD-DCM utilizes a precision analog-to-digital converter and ultra-stable passive components to achieve excellent performance over the operating temperature range of 0 to +60°C. A rugged, ABS plastic package provides excellent protection against shock and vibration. DMS-20LCD-DCM's are without a doubt the most cost-effective, LCD-display, digital voltmeters available anywhere, at any price.



Functional Specifications

Input	
Voltage Range: ①	
DMS-20LCD-0-DCM	+6.50 to +18.00Vdc
DMS-20LCD-1-DCM	+8.0 to +40.0Vdc
Current Consumption:	
DMS-20LCD-0-DCM	3mA (max. at VIN=+12V)
DMS-20LCD-1-DCM	2.5mA (max. at VIN=+24V)
Performance	
Sampling Rate	2.5 readings/second
Accuracy @ +25°C:	
DMS-20LCD-0-DCM	±0.01V (typ.), ±0.03V (max.)
DMS-20LCD-1-DCM	±0.1V (typ.), ±0.2V (max.)
Temperature Drift (0 to +60°C):	
DMS-20LCD-0-DCM	±0.4 counts/°C (max.)
DMS-20LCD-1-DCM	±0.04 counts/°C (max.)
Mechanical	
Display Type:	
DMS-20LCD-0-DCM	3½ digit LCD, 0.37"/9.4mm high
DMS-20LCD-1-DCM	3 digit LCD, 0.37"/9.4mm high
Weight	0.5 ounces (14 grams)
Case Material	ABS
Environmental	
Operating Temperature	0 to +60°C
Storage Temperature	–20 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at voltages above or below these ranges are not specified.

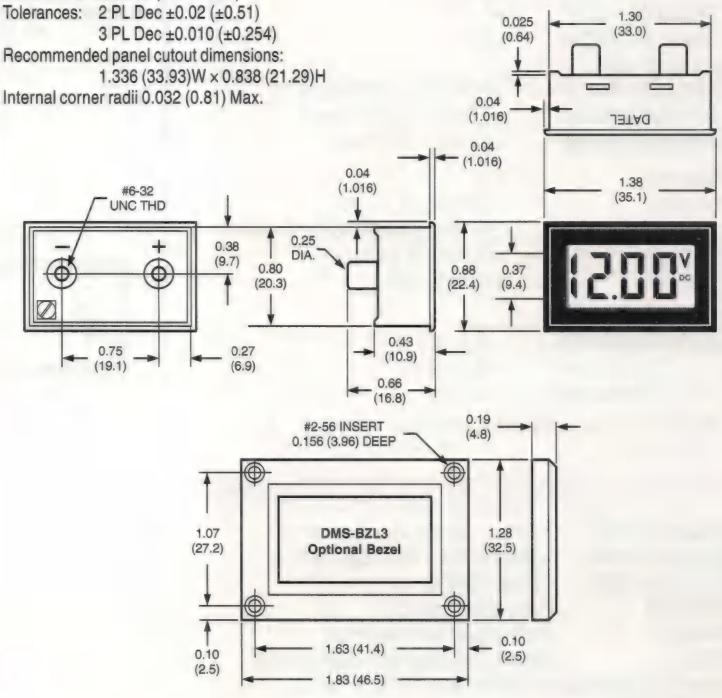
Ordering Information

DMS-20LCD-0-DCM	+6.50-18.00V dc voltage monitor
DMS-20LCD-1-DCM	+8.0-40.0V dc voltage monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0348 Rev. A

DATEL
INNOVATION and EXCELLENCE

Actual Size

DMS-20PC-0/1/2-DCM

Self-Powered, LED, Positive Input, DC Voltage Monitors

Features

- **Self-powered, only two connections required**
- **+4.5-20Vdc, +18-50Vdc and +30-264Vdc models**
- **Ideal replacements for analog panel meters**
- **Ultra-low power consumption (8mA typ.)**
- **0.37"/9.4mm high, bright red, LED displays**
- **Subminiature 1.38" x 0.88" x 1.0" packages**
- **Super reliable, epoxy-encapsulated, construction**

Functional Specifications

Input

Voltage Range: ①	
DMS-20PC-0-DCM	+4.50 to +19.99Vdc
DMS-20PC-1-DCM	+18.0 to +50.0Vdc
DMS-20PC-2-DCM	+30 to +264Vdc
Current Consumption:	
DMS-20PC-0/1-DCM	13mA (max.)
DMS-20PC-2-DCM	7mA (max.)

Performance

Sampling Rate	2.5 readings/second
Resolution:	
DMS-20PC-0-DCM	±0.01V
DMS-20PC-1-DCM	±0.1V
DMS-20PC-2-DCM	±1V
Accuracy @ +25°C:	
DMS-20PC-0-DCM	±0.01V (typ.), ±0.03V (max.)
DMS-20PC-1-DCM	±0.1V(typ.), ±0.2V (max.)
DMS-20PC-2-DCM	±1V(typ.), ±2V (max.)

Mechanical

Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 & 3½ digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate

Environmental

Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below these ranges are not specified.

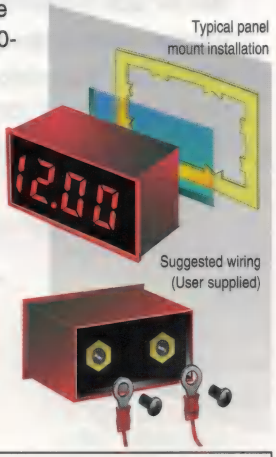
Ordering Information

DMS-20PC-0-DCM	+4.50 to +19.99V dc voltage monitor
DMS-20PC-1-DCM	+18.0 to +50.0V dc voltage monitor
DMS-20PC-2-DCM	+30 to +264V dc voltage monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel assembly
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

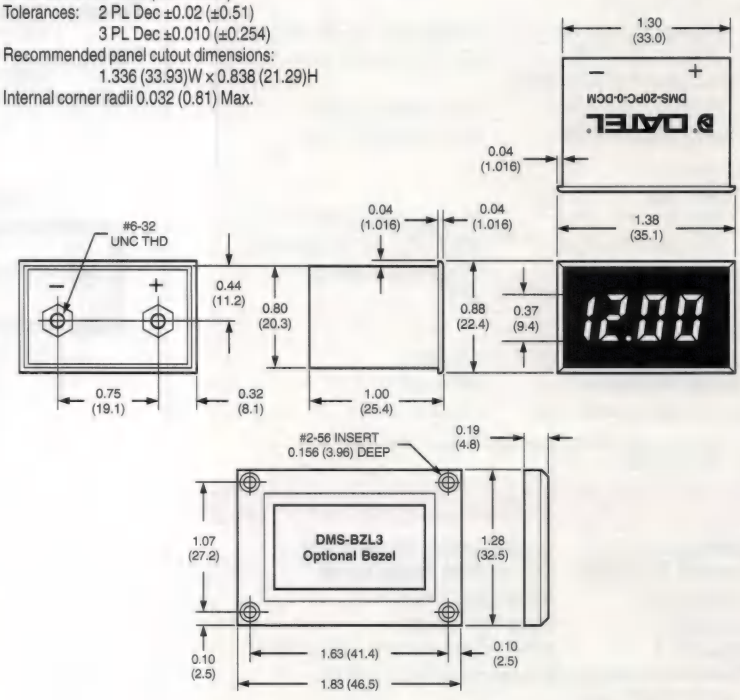
DATEL's DMS-20PC-DCM Series of self-powered, positive-reading, dc voltage monitors are great replacements for older, hard-to-read, analog panel meters. Simply connect a positive dc voltage across the rear terminals and the meters are fully operational — no additional components or power supplies are required! The large, 0.37"/9.4mm, bright red, LED displays can be easily read from 15 feet away. Three versions are available: one for +4.50-19.99Vdc (0.01V resolution), one for +18.0-50.0Vdc (0.1V resolution), and one for +30-264Vdc (1V resolution). Built-in reverse polarity protection assures simple, trouble-free installation.

All DMS-20PC-DCM's employ a high-resolution, 3½ digit A/D converter and precision metal-film resistors to achieve outstanding performance over an operating temperature range of –25 to +60°C. A rugged, epoxy-encapsulated, polycarbonate case provides excellent protection against moisture, shock and vibration. The DMS-20PC-DCM's are designed to fit the same panel cutout as DATEL's popular DMS-20PC-X-LM ac line voltage monitors.



Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



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Actual Size

DMS-20PC-3-DCM

+2 to +6Vdc, Self-Powered LED Display, DC Voltage Monitor

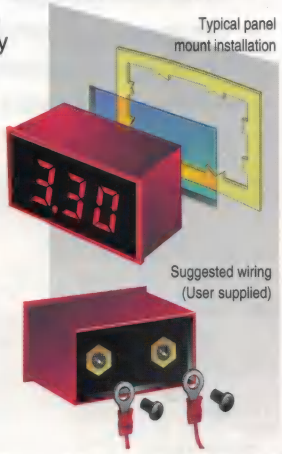
Features

- **Self-powered, only two connections required**
- **+2.00 to +6.00Vdc input range**
- **0.01V resolution; ±0.05% accuracy**
- **Ideal for low-voltage (3.3V) power supply monitoring**
- **Digital replacement for analog panel meters**
- **0.37"/9.4mm, bright red, LED display**
- **Subminiature 1.38" x 0.88" x 1.0" package**
- **Super reliable, epoxy-encapsulated construction**
- **Reverse polarity protected**
- **–25 to +60°C temperature range**
- **Low power consumption**

DATEL's new DMS-20PC-3-DCM self-powered dc voltage monitor is perfect for precision monitoring of all low-voltage power supplies. Simply connect a positive dc voltage across its two rear terminals and the meter is fully operational with no additional components required! A measurement resolution of 0.01Vdc enables precise adjustment of power supply outputs. The large, 0.37"/9.4mm, bright red, LED display, unlike most LCD's, can be easily read from 15 feet away under virtually any lighting conditions. Built-in reverse polarity protection assures quick, trouble-free installation.

The DMS-20PC-3-DCM utilizes a high-resolution, 3 digit analog-to-digital converter and precision metal-film resistors to achieve outstanding performance over its operating temperature range of –25 to +60°C. A rugged, epoxy-encapsulated, polycarbonate case provides excellent protection against moisture, shock and vibration.

The DMS-20PC-3-DCM uses the same panel cutout dimensions as all DMS-20 Series panel voltmeters and monitors; this feature assures uniform displays in multiple-meter applications.



Functional Specifications

Input	
Voltage Range ①	+2.00 to +6.00Vdc
Current Consumption	
@Vin = 2/3/6Vdc	55/80/50mA (max.)
Reverse Polarity Protection	6V (max.)
Performance	
Sampling Rate	2.5 readings/second
Resolution	0.01V
Accuracy @ +25°C	±0.01V (typ.), ±0.02V (max.)
Temperature Drift	
(–25 to +60°C)	±0.3 counts/°C (max.)
Mechanical	
Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate
Environmental	
Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below this range are not specified.

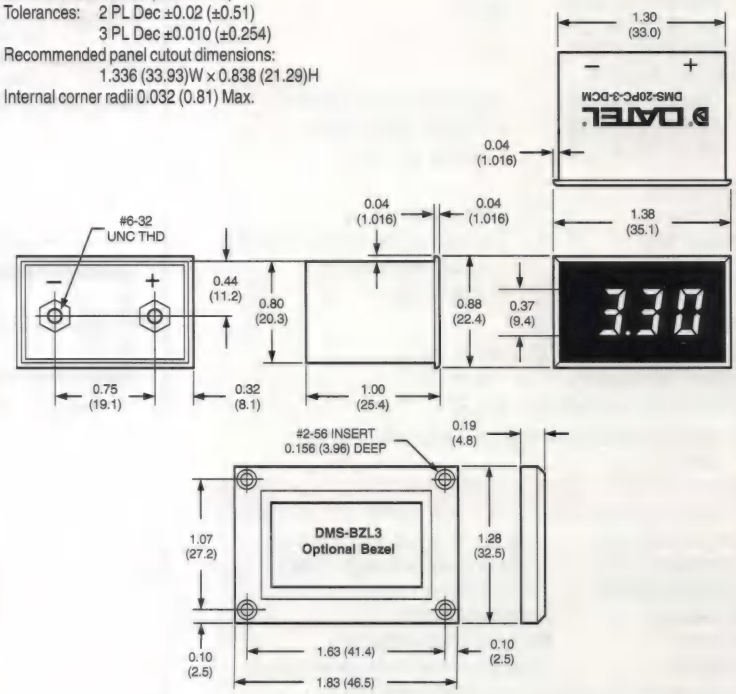
Ordering Information

DMS-20PC-3-DCM	+2.00 to +6.00V dc voltage monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel assembly
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0350 Rev. A

Actual Size

DMS-20PC-4/5/6-DCM

Self-Powered, LED, Negative Input, DC Voltage Monitors

Features

- **Self-powered, only two connections required**
- **–4.5 to –20Vdc, –18 to –50Vdc, and –30 to –264Vdc models**
- **Can be used with positve-reading DMS-20PC-DCM's**
- **Ultra-low power consumption (8mA typ.)**
- **0.37"/9.4mm high, bright red, LED displays**
- **Subminiature 1.38" x 0.88" x 1.0" packages**

Functional Specifications

Input

Voltage Range: ①	
DMS-20PC-4-DCM	–4.50 to –19.99Vdc
DMS-20PC-5-DCM	–18.0 to –50.0Vdc
DMS-20PC-6-DCM	–30 to –264Vdc
Current Consumption:	
DMS-20PC-4/5-DCM	13mA (max.)
DMS-20PC-6-DCM	7mA (max.)

Performance

Sampling Rate	2.5 readings/second
Resolution:	
DMS-20PC-4-DCM	±0.01V
DMS-20PC-5-DCM	±0.1V
DMS-20PC-6-DCM	±1V
Accuracy @ +25°C:	
DMS-20PC-4-DCM	±0.01V (typ.), ±0.03V (max.)
DMS-20PC-5-DCM	±0.1V(typ.), ±0.2V (max.)
DMS-20PC-6-DCM	±1V(typ.), ±2V (max.)

Mechanical

Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 & 3½ digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate

Environmental

Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below these ranges are not specified.

Ordering Information

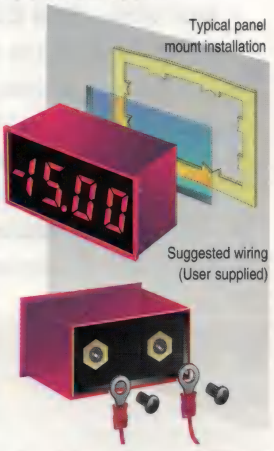
DMS-20PC-4-DCM	–4.50 to –19.99V dc voltage monitor
DMS-20PC-5-DCM	–18.0 to –50.0V dc voltage monitor
DMS-20PC-6-DCM	–30 to –264V dc voltage monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel assembly
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

DATEL's DMS-20PC-DCM Series of self-powered, negative-reading, dc voltage monitors are great replacements for older, hard-to-read, analog meters. Simply connect a negative voltage across the rear terminals and the meters are fully operational! Negative-input DCM's can be easily combined with positive-reading DMS-20PC-DCM's for monitoring dual-polarity power supplies.

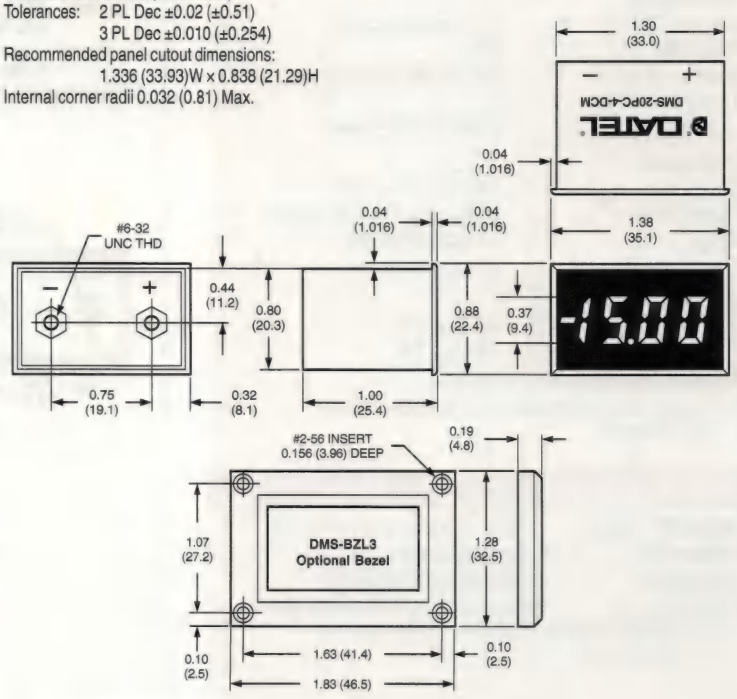
Three versions are available: one for –4.50 to –19.99Vdc (0.01V resolution), one for –18.0 to –50.0Vdc (0.1V resolution), and one for –30 to –264Vdc (1V resolution). Their large, 0.37"/9.4mm, bright red LED displays can be easily read from 15 feet away. Built-in reverse polarity protection assures simple, trouble-free installation.

All DMS-20PC-DCM's employ a high-resolution, 3½ digit A/D converter and precision metal-film resistors to achieve outstanding performance over an operating temperature range of –25 to +60°C. A rugged, epoxy-encapsulated, polycarbonate case provides excellent protection against moisture, shock and vibration.



Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
3 PL Dec ±0.010 (±0.254)
Recommended panel cutout dimensions:
1.336 (33.93)W x 0.838 (21.29)H
Internal corner radii 0.032 (0.81) Max.



DS-0349 Rev. A

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Actual Size

DMS-20PC-7-DCM

–36 to –75Vdc, Self-Powered LED Display, DC Voltage Monitor

Features

- **Great for –48Vdc telecom power monitoring**
- **Self-powered 2-wire operation**
- **–36 to –75V operating input range**
- **Ultra-low power consumption, 8mA (typ.) at –48V**
- **–200V input transient protection**
- **Reverse polarity protected to +100V**
- **0.37"/9.4mm high, bright red, LED display**
- **Subminiature 1.38" x 0.88" x 1.0" package**
- **Super reliable, epoxy-encapsulated construction**
- **–25 to +60°C operating temperature range**

Functional Specifications

Input	
Voltage Range ①	–36.0 to –75.0Vdc
Current Consumption	13.0mA (max.)
Reverse Polarity Protection	+100V (max.)
Transient Protection	–200V (1µsec duration)
Performance	
Sampling Rate	2.5 readings/second
Resolution	0.1V
Accuracy @ +25°C	±0.1V (typ.), ±0.2V (max.)
Temperature Drift (–25 to +60°C)	±0.2 counts/°C (max.)
Mechanical	
Dimensions	1.38" x 0.88" x 1.00"
Display Type	3 digit, red LED, 0.37"/9.4mm
Weight	1 ounce (28 grams)
Case Material	Polycarbonate
Environmental	
Operating Temperature	–25 to +60°C
Storage Temperature	–40 to +75°C
Humidity (Non-condensing)	0 to 95%

① Operation and accuracy at inputs above or below this range are not specified.

Ordering Information

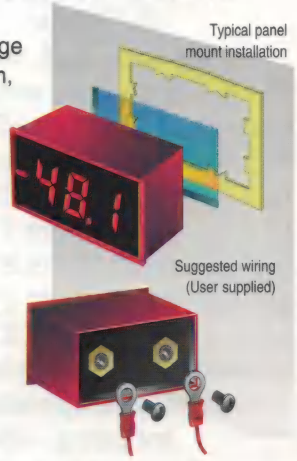
DMS-20PC-7-DCM	–36.0 to –75.0V dc voltage monitor
DMS-20-CP	Panel cutout punch
DMS-BZL3	Panel mount bezel assembly
DMS-BZL4	Panel mount bezel with sealing gasket

Brass screws (6-32 thread) and a panel-mount retaining clip are supplied with each meter

DATEL's new DMS-20PC-7-DCM self-powered digital voltage monitor is designed for monitoring –48V intermediate bus voltages in modern telecom/datacom/computer equipment. Its compact size and low power consumption (8mA typical) make it the ideal replacement for older, hard-to-read, analog panel meters. Simply connect a –36 to –75Vdc input across the two rear terminals and the meter is fully operational!

The DMS-20PC-7-DCM's subminiature package (1.38" x 0.88" x 1.0") houses a large, 0.37"/9.4mm, bright red LED display which can be easily read from 15 feet away. Built-in reverse polarity and transient protection assures simple, trouble-free installation.

The DMS-20PC-7-DCM employs a high-resolution, 3½ digit analog-to-digital converter and precision metal-film resistors to achieve outstanding performance over its entire operating temperature range of –25 to +60°C. A rugged, epoxy-encapsulated, polycarbonate case (available only from DATEL!) provides excellent protection against moisture, shock and vibration.



Mechanical Specifications

Dimensions in inches (millimeters)
Tolerances: 2 PL Dec ±0.02 (±0.51)
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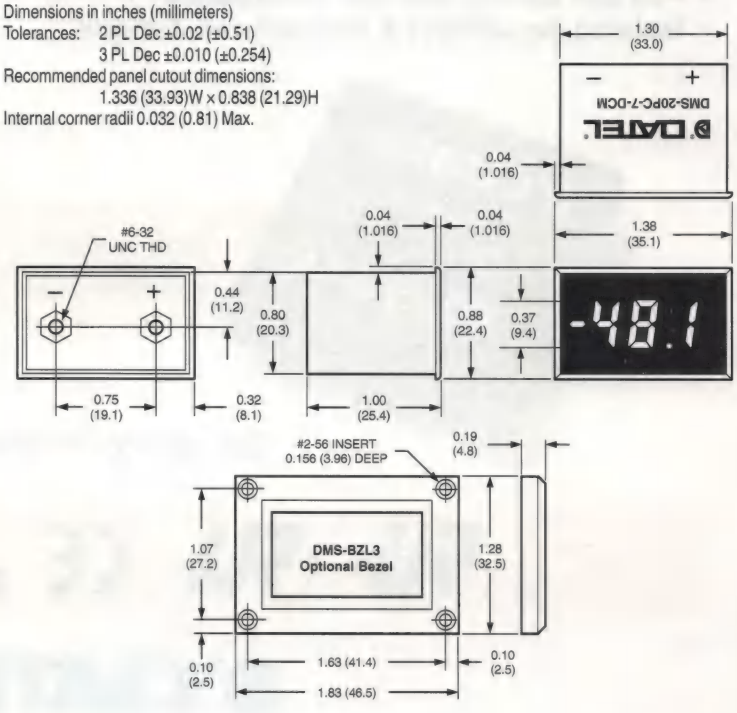
Internal corner radii 0.032 (0.81) Max.



DS-0389 Rev. A

DC/DC Converters

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- **Low prices! Immediate delivery!**
- **Wide range inputs:**
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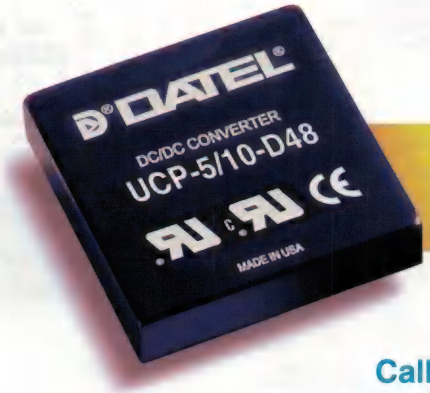
  9-36 Volts
  18-72Volts
- **Single, dual, triple or quad outputs**
- **All popular output voltages:**
  2.1V, 3.3V, ±5V, –5.2V, ±12V, ±15V
- **Small, standard, plug-in packages:**
  to 3 Watts 1.25" x 0.8"
  to 10 Watts 1" x 1"
  to 25 Watts 2" x 1"
  to 50 Watts 2" x 2"
  to 60 Watts 2.4" x 2.3"
- **High efficiencies (>90%)**
- **Wide temperature ranges**
  Including –40°C to +100°C
- **5 or 6-sided shielding**
- **Full EMI testing and EMC compliance**
- **Isolated (to >2200V) & non-isolated designs**



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Process Control Monitors

When the industry leader in miniaturized digital panel meters and low-power LED/LCD technology decides to develop a line of 4-to-20mA and 0-5V process control monitors, you can expect some impressive results.

How about the first, 4-20mA loop-powered, 3½ digit local readout with a bright red LED display that can be read from as far away as 15 feet - even at 4mA! Or a 4-20mA readout with a full-size (0.56"/14.2mm) LED display that comes in 4 different colors and operates from any supply voltage between 7.5 and 32 Volts! How about loop-powered LCD meters with either 3½ or 4½ digit resolutions and three different display sizes, or dedicated 0-5V, LED-display meters that require only 4 connections (2 for signal, 2 for power)!

These products and more appear in the following pages ... and they are all astonishingly simple to install and surprisingly affordable.

Exactly what you'd expect from DATEL!

Table of Contents

Selection Guide 4-2

Loop-Powered, 4-to-20mA Local Readouts

DMS-20PC-4/20S Subminiature Package, 3½ Digit LED Display 4-3
DMS-20LCD-4/20S Subminiature Package, 3½ Digit LCD Display 4-6
DMS-30LCD-4/20S Miniature Package, 3½ Digit LCD Display 4-7
DMS-40LCD-4/20S Miniature Package, 4½ Digit LCD Display 4-10

Locally Powered, 4-to-20mA Readouts

DMS-30PC-4/20S Miniature Package, 3½ Digit, Full-Size LED Display 4-12
DMS-40PC-4/20S Miniature Package, 4½ Digit, Full-Size LED Display 4-15

0-to-5V Process Control Monitors

DMS-20PC-0/5 Dedicated 0-to-5V Input, 3½ Digit LED Display 4-17

Selection Guide

Process Control Monitors

Input	Power Supply	Display Type ①	Display Resolution	DATEL Model Number	Features	Page
4-20mA	Loop Powered	LED	3½ Digits	DMS-20PC-4/20S	The first, loop-powered, LED readouts.	4-3
		LCD	3½ Digits	DMS-20LCD-4/20S	2V loop drop. On-board gain/offset adjustments. DIP switch for 100's of input/readout combinations.	4-6
			3½ Digits	DMS-30LCD-4/20S		4-7
			4½ Digits	DMS-40LCD-4/20S		4-10
	+5V or +7.5-32V	LED	3½ Digits	DMS-30PC-4/20S	4 connections (2 loop, 2 power). 4 LED options. +5-32V supplies.	4-12
			4½ Digits	DMS-40PC-4/20S		4-15
0-5V	+5V or +5-40V	LED	3½ Digits	DMS-20PC-0/5	100kΩ input impedance. 4 LED options.	4-17

① See page V for display options/colors and package outline dimensions.

LED vs. LCD Displays in Loop-Powered Meters

Historically, LED displays (even those with the smallest digit heights) have dissipated 100's of milliwatts of power while LCD displays have dissipated a few microwatts of power. This simple fact explains why loop-powered digital panel meters (local readouts) have been relegated to using LCD displays despite the more desirable, higher visibility, all-angle readability of LED displays.

Loop-powered meters must derive all their operating power from the 4-20mA loop, and the challenge of maintaining LED display brightness at the low end of the current range (i.e. at 4mA) has been insurmountable. Assuming the loop is carrying 4mA and the local readout has a 5V drop across its two terminals, the maximum power available for powering the meter is 4mA x 5V = 20mW. Considering the meter consists not only of its display but also an A/D converter, a temperature compensated reference circuit, display drivers and more, you can see why loop-powered LED meters have been a rarity.

The enabling technology for DATEL's industry-first, loop-powered LED meters is our proprietary low-power LED's. Boasting brightness levels that surpass those of standard-intensity, high-current LED's, DATEL's low-power LED's require astonishingly low drive currents and are easily read from as far away as 15-20 feet.

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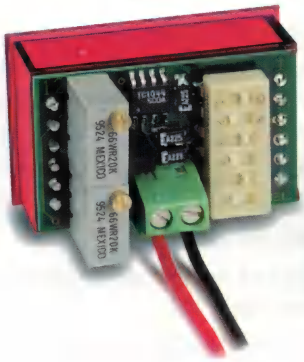


Actual Size

DMS-20PC-4/20S

Subminiature 4-20mA Loop-Powered 3½ Digit, LED Meter

Features

- **Industry's first loop-powered meter with a large, easy-to-read, LED display!**
- **Self-powered, no external supply required**
- **Large, 0.37"/9.4mm digits**
- **Excellent display intensity with 4mA inputs**
- **Constant 5V max. total loop drop**
- **High-quality, 20-turn, span (gain) and zero (offset) adjustments**
- **DIP-switch selectable range and decimal points**
- **Hundreds of different input/readout combinations**
- **Vibration-resistant package; Reliable screw-terminal input connections**

The DMS-20PC-4/20S is the world's first, loop-powered, digital panel meter with a large, easy-to-read, bright red, LED display. All operating power is derived directly from the loop current itself—no external power supply is required! The large, 0.37"/9.4mm digits exhibit uniform intensity over the entire 4-20mA operating range. Additionally, the total maximum loop voltage drop is only 5V! Users no longer have to settle for difficult-to-read LCD displays in loop-powered applications.

Both gain (span) and offset (zero) adjustments are performed with on-board, precision, 20-turn potentiometers. All decimal-point and range-change selections are made on a six-position DIP switch featuring vibration-resistant, gold-plated contacts. Unlike competitive meters, there are no jumpers or solder gaps to open or close. Connections to the current loop are made via a reliable, two-position, screw-type terminal block.

The DMS-20PC-4/20S's DIP switch and adjustment potentiometers accommodate hundreds of different input-current/output-reading combinations. This versatility practically eliminates the need to order more costly, long-lead-time, factory-customized "specials" in applications in which several different-range meters are required. An optional bezel assembly, featuring screw fasteners and a rubber seal, simplifies panel mounting and provides excellent resistance to environmental dust and moisture. All these outstanding features combine to make the DMS-20PC-4/20S the perfect meter for prototype and OEM 4-20mA current-loop instrumentation.

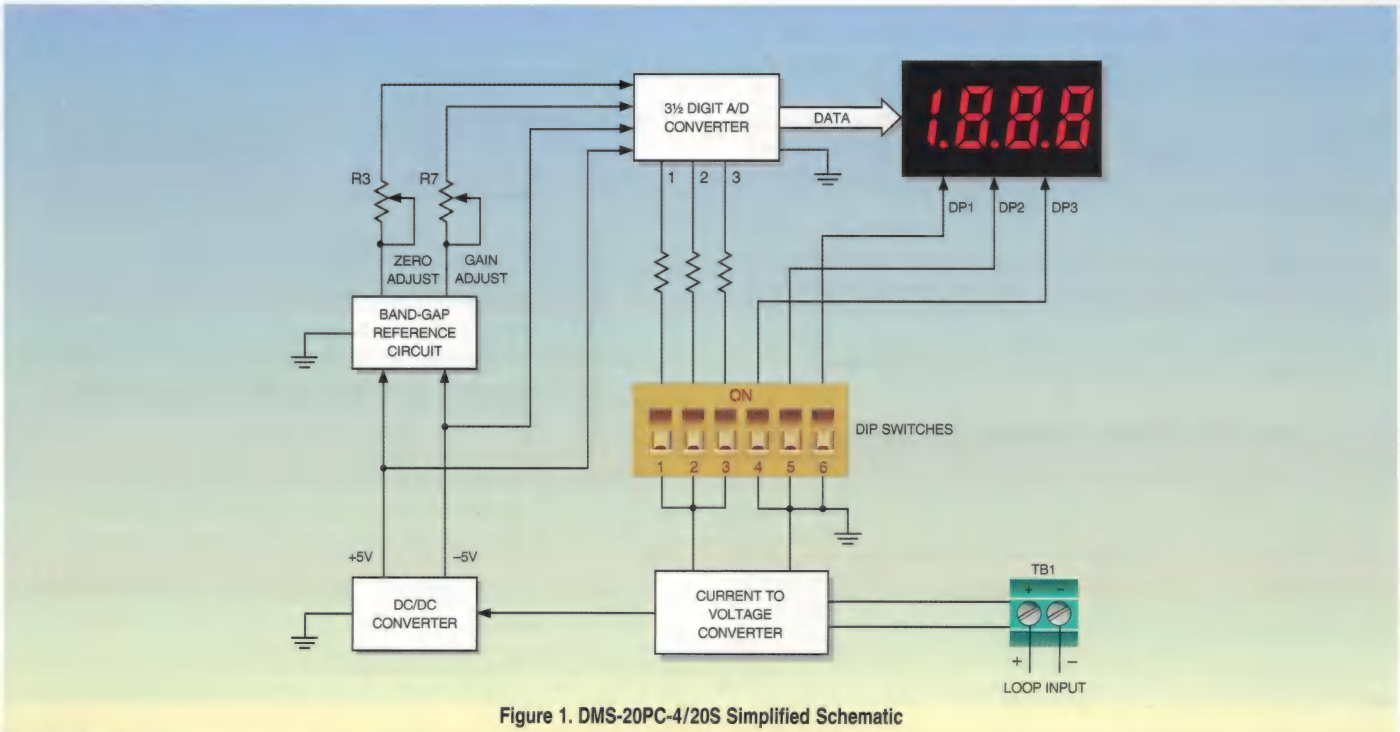


Figure 1. DMS-20PC-4/20S Simplified Schematic

4

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Current Loop Input	Min.	Typ.	Max.	Units
Full Scale Input Range ①	+4	--	+20	mA
Input Impedance ②	--	250	--	Ω
Voltage Drop ②	--	4.5	5.0	Volts
Overcurrent Protection ①	--	--	±40	mA
Performance				
Sampling Rate	2.5 readings per second			
Accuracy (1 minute warm-up)	±0.05%FS ±1 Count			
Temperature Drift (0 to +60°C)	--	±0.15	±0.3	Cnts/°C
Display				
Display Type and Size	3½ digit, red LED, 0.37"/9.4mm			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–1___" for negative inputs "1___" for positive inputs			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–40	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.6 ounces (17 grams)			

DIP-Switch Settings Table ③

Display Reading	SW1	SW2	SW3
1. 000 to 1050-1999	Off	Off	Off
2. 000 to 650-1350	On	Off	Off
3. 000 to 450-800	Off	On	Off
4. 000 to 300-500	Off	Off	On
5. 000 to 200-300	On	On	On

① The DMS-20PC-4/20S, using any of the DIP-switch settings described above, can withstand overcurrents, including those resulting from accidental reverse-polarity connections, up to ±40mA without sustaining any damage.

② Because DATEL's DMS-4/20 loop-powered meters employ active circuitry to convert the loop current into a voltage, the meters' effective series impedance varies in a manner that maintains the loop voltage drop constant over the full 4-to-20mA current range. Listed impedance specification applies at 20mA.

③ When looking up DIP-switch settings in the Table and the desired display readings can be achieved with either of two different switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-20PC standard meter (from which the DMS-20PC-4/20S is derived) has an accuracy specification of ±2 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Ordering Information

DMS-20PC-4/20S	3½ digit, LED, loop-powered meter
DMS-BZL3	Bezel assembly
DMS-BZL4	Bezel assembly with sealing gasket
DMS-20-CP	Panel cutout punch

A panel-mount retaining clip is supplied with each model.

Operating and Setup Instructions

As shipped, the DMS-20PC-4/20S is factory calibrated to read "000" for a 4mA input and "1000" for a 20mA input. The following worst-case procedure assumes the DMS-20PC-4/20S is completely mis-adjusted, i.e., both potentiometers and the DIP switches are randomly set.

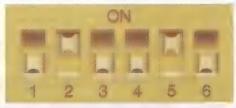
1. Set R7 (full scale span/gain adjust) and R3 (zero/offset adjust) fully clockwise, roughly 22 turns, and place SW1-SW6 to OFF.
2. Select DIP switch setting #2.
3. Apply a precision 4mA input, with proper polarity, and adjust R3 until the meter's display reads "000".
4. Apply a precision 20mA input and adjust R7 until the meter's display reads "1000". Repeat steps 3 and 4 to make sure the adjustments do not affect one another.
5. Select the appropriate decimal point by setting SW4, SW5 or SW6 to ON (DP3, DP2 or DP1 respectively).

   NOTE: If a display reading other than "000" to "1000" is desired, refer to DIP-Switch Settings Table for SW1-SW3 settings.

Examples

1. Desired display readings are:

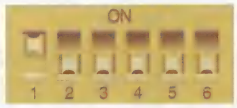
   4mA ="0.00"
   20mA = "6.00"



   Use DIP-switch setting #3 and enable decimal point DP2 via SW5. Apply 4mA and adjust R3 so the display reads "0.00". Apply 20mA and adjust R7 so the display reads "6.00".

2. Desired display readings are:

   4mA = "000"
   20mA = "800"



   Use DIP-switch setting #2. Apply 4mA and adjust R3 so the display reads "000". Apply 20mA and adjust R7 so the display reads "800". For these display readings, no decimal points are used. Set SW4, SW5 and SW6 to OFF.

3. Desired display readings are:

   4mA = ".000"
   12mA = ".250"

   This example is not as straightforward as the previous two. Notice that 12mA is exactly halfway between 4mA and 20mA. If we assume that the input could go up to 20mA, the display reading would then be: 2 x .250 or ".500". From the table, we can now select DIP-switch setting #4 and enable DP1 via SW6. Apply 4mA and adjust R3 so the display reads ".000". Apply 12mA and adjust R7 so the display reads ".250".

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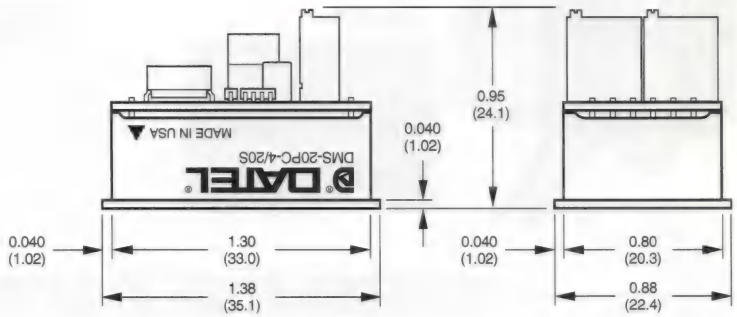
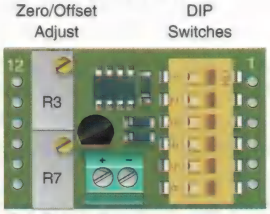
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

TOLERANCES:	2 PL DEC ±0.02 (±0.51) 3 PL DEC ±0.010 (±0.254)
WIRE SIZE:	18 to 26 AWG (Solid or stranded)
STRIPPING LENGTH:	0.20" (5.08mm)

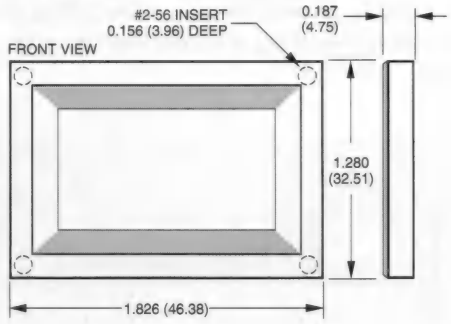


Back View

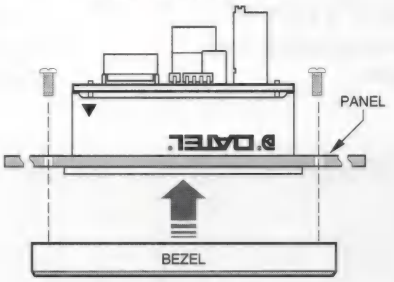


Front View

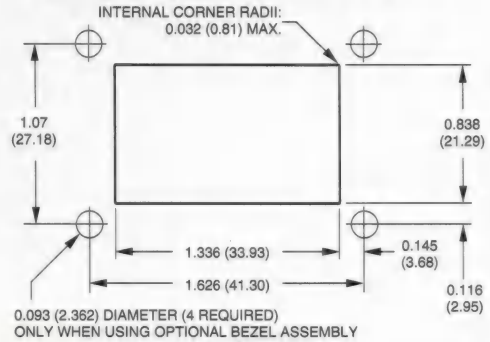
OPTIONAL BEZEL (DMS-BZL3 and DMS-BZL4)



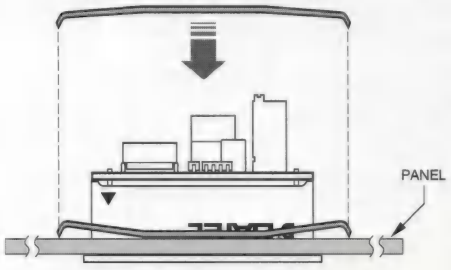
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



RETAINING CLIP INSTALLATION



DS-0353 Rev. A

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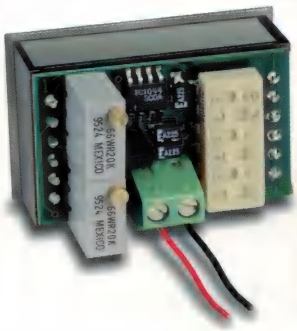

Actual Size

Available 2nd Quarter 1998

DMS-20LCD-4/20S

Subminiature 4-20mA Loop-Powered 3½ Digit, LCD Meter

Preliminary Information

Features

- 2.5V max. loop drop
- Loop-powered; no external supply required
- Subminiature size:
  1.38" x 0.88" x 0.90"
  35mm x 22mm x 23mm
- Large (0.37"/9.4mm), enhanced-contrast, LCD display
- On-board gain (span) and offset (zero) adjustments
- DIP-switch selectable range and decimal points
- Reverse-polarity protected
- Reliable, screw-terminal input connections

DATEL's DMS-20LCD-4/20S loop-powered, LCD-display local readout is unquestionably the most versatile, easiest-to-use product of its type. All necessary operating power is derived solely from the 4-20mA current loop with absolutely no external power supplies or support components required. All gain (span) and offset (zero) adjustments are accomplished with on-board, precision, 20-turn potentiometers. All decimal-point and range-change selections are made on an easy-to-use DIP switch featuring vibration and corrosion-resistant, gold-plated contacts. Virtually any input-current/output-readout relationship can be achieved.

There are no cumbersome jumpers or solder gaps to contend with. Connections to the loop are made via reliable, two-position, screw-type, terminal blocks. The only assembly tool required is a screwdriver!

The DMS-20LCD-4/20S consists of DATEL's super-reliable, epoxy-encapsulated DMS-20LCD panel meter and a 4-20mA adapter board. The entire assembly features 100% soldered connections and delivers a level of long-term reliability not available in competing products costing two to three times as much.

An optional bezel assembly, featuring screw fasteners and an EPDM rubber gasket, is available for panel-mount applications requiring increased resistance to environmental dust and moisture.

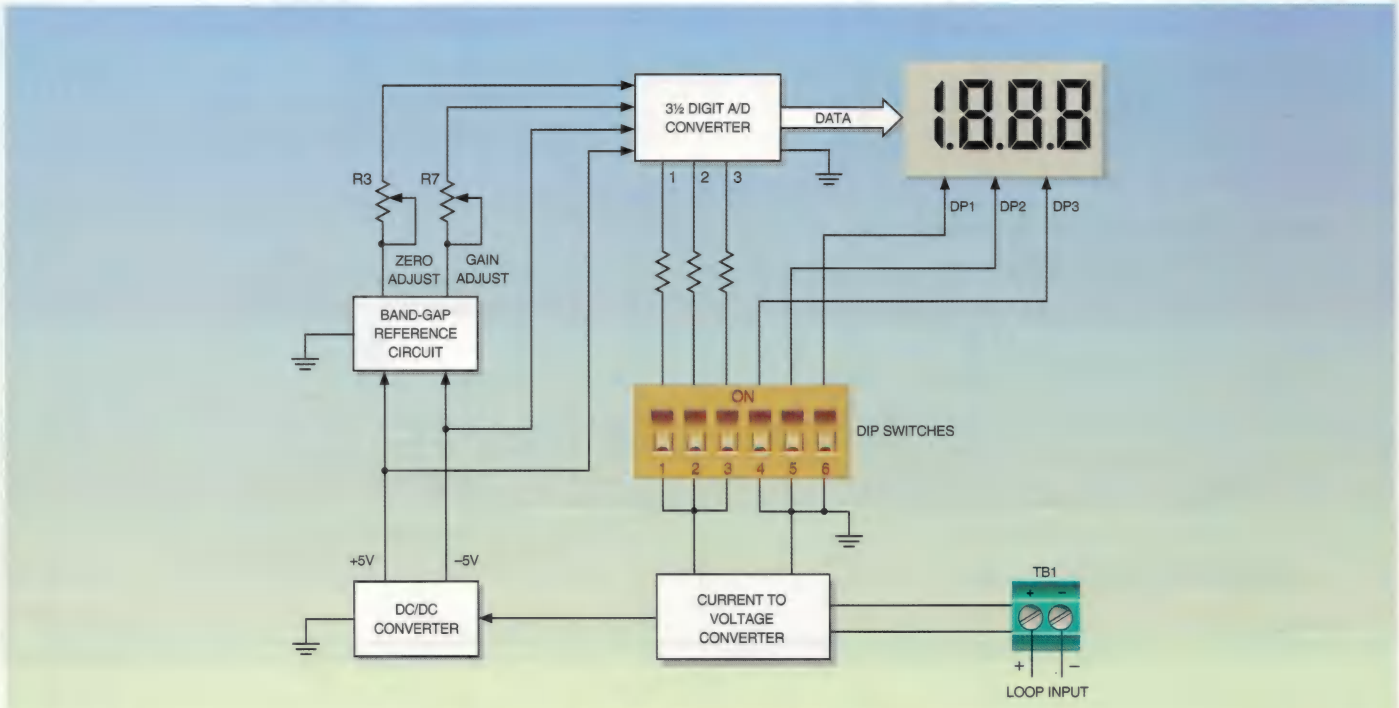

Figure 1. DMS-20LCD-4/20S Simplified Schematic

DS-0400 Preliminary

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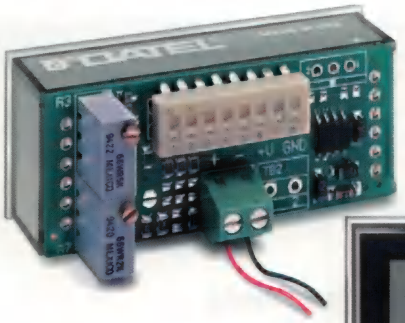


Actual Size

DMS-30LCD-4/20S

4-20mA Input Loop-Powered 3½ Digit, LCD Meter

Features

- **Loop-powered; no external supply required**
- **Includes gain (span) and offset (zero) adjustments**
- **DIP-switch selectable range and decimal points**
- **Large (0.40"/10.2mm) LCD digits**
- **Reverse-polarity protected**
- **Reliable screw-terminal input connections**
- **Rugged, vibration-resistant package**
- **Miniature size:**
  2.17" x 0.92" x 0.95"
  55mm x 23mm x 24mm
- **Low cost**

The DMS-30LCD-4/20S is unquestionably the easiest-to-use, most versatile product of its type. All necessary operating power is derived solely from the current loop input — no external components or power supplies are required. Constructed using DATEL's super-reliable, epoxy-encapsulated, DMS-30LCD digital voltmeter, the entire assembly features 100% soldered connections. This high level of reliability is not available in competitive products costing two to three times as much!

Gain (span) and offset (zero) adjustments are both performed with precision, 22-turn potentiometers. All decimal point and range-change selections are made on an easy-to-use, seven-position DIP switch which features vibration-resistant, gold-plated contacts. There are no cumbersome jumpers or solder gaps to contend with! Connections to the loop are made via a reliable, two-position, screw-type terminal block. The only assembly tool required is a screwdriver!

The DMS-30LCD-4/20S's design accommodates hundreds of different input-current/output-reading combinations. This essentially eliminates the need to order more costly, long-lead-time "specials" in applications in which several different-range meters are required. An optional bezel assembly, featuring screw fasteners and an EPDM rubber seal, is available for applications requiring moisture resistance. The DMS-30LCD-4/20S is the perfect choice for both prototype and OEM requirements.

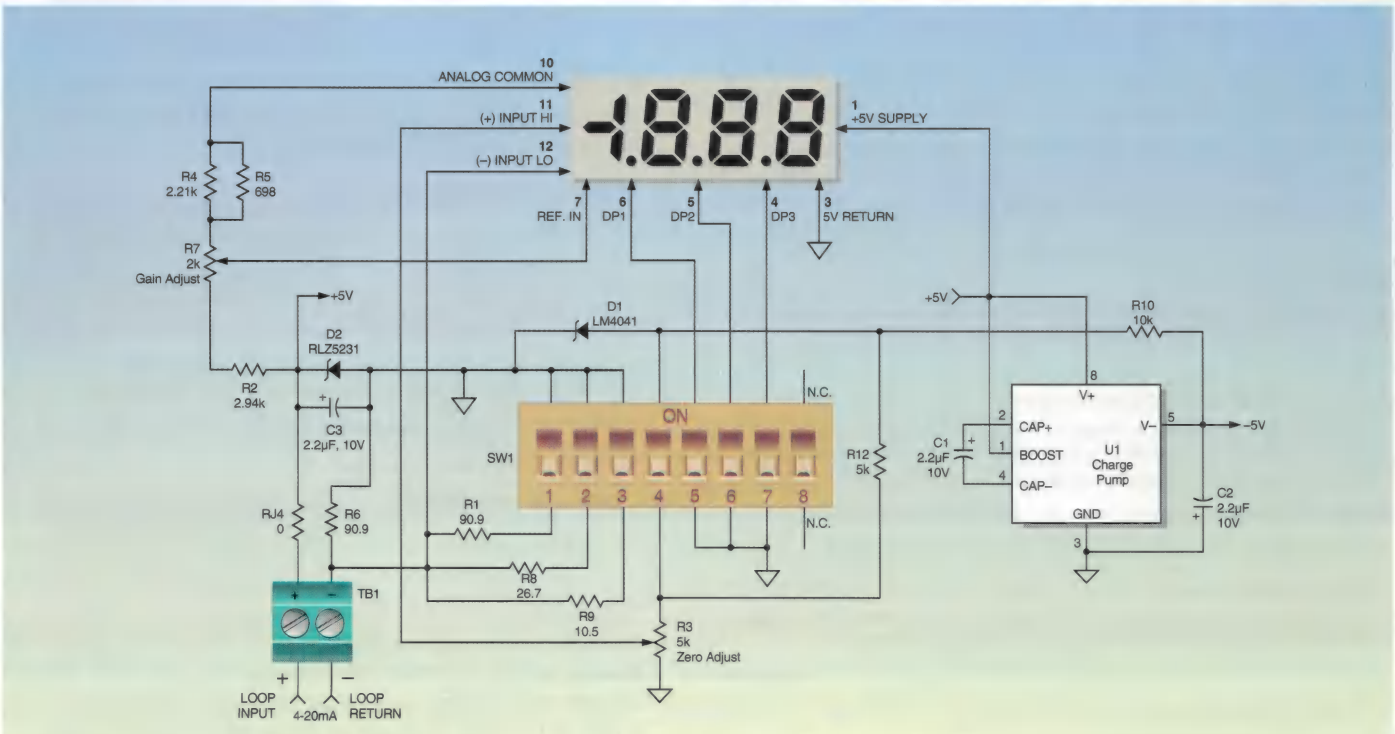


Figure 1. DMS-30LCD-4/20S Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Current Loop Input	Min.	Typ.	Max.	Units
Full Scale Input Range ①	+4	--	+20	mA
Input Impedance ② ③	--	550	--	Ω
Voltage Drop ② ③	--	--	7.5	Volts
Overcurrent Protection ①	--	--	±40	mA
Performance				
Sampling Rate	2.5 readings per second			
Accuracy (1 minute warm-up)	±0.05%FS ±1 Count			
Temperature Drift (0 to +60°C)	--	±0.15	±0.3	Cnts/°C
Display				
Display Type and Size	3½ digit LCD, 0.4"/10.2mm high			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–1___" for negative inputs "1___" for positive inputs			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–20	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	0.75 ounces (21 grams)			

DIP-Switch Settings Table ④

Display Reading	SW1	SW2	SW3	SW4
1. 000 to 100-300	On	On	On	Off
2. 000 to 400-600	Off	On	On	Off
3. 000 to 700-1999	On	Off	Off	Off
4. ±100	On	On	On	Off
5. ±200 to ±300	On	On	Off	Off
6. ±400 to ±600	On	Off	Off	Off
7. ±700 to ±1900	Off	Off	Off	On

① The DMS-30LCD-4/20S, using any of the DIP-switch settings described above, can withstand overcurrents, including those resulting from accidental reverse-polarity connections, up to ±40mA without sustaining any damage. The meter can be used in most 10-50mA loop applications using DIP-switch settings 1-6. DIP-switch setting #7 can not be used in any application in which the current can exceed ±40mA.

② As a result of an ongoing product redesign, loop voltage drop will be reduced to 2V max. after March, 1998. Series impedance will be changed to 100Ω typ. See note 3.

③ Because DATEL's DMS-4/20 loop-powered meters employ active circuitry to convert the loop current into a voltage, the meters' effective series impedance varies in a manner that maintains the loop voltage drop constant over the full 4-to-20mA current range. Listed impedance specification applies at 20mA.

④ When looking up DIP-switch settings in the Table and the desired display readings happen to fall between two switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-30LCD meter (from which the DMS-30LCD-4/20S is derived) has an accuracy specification of ±2 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Ordering Information

DMS-30LCD-4/20S	3½ digit, LCD, loop-powered meter
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket
DMS-30-CP	Panel cutout punch

A panel-mount retaining clip is supplied with each model.

Operating and Setup Instructions

As shipped, the DMS-30LCD-4/20S is factory calibrated to read "000" for a 4mA input and "1999" for a 20mA input. The following worst-case procedure assumes the DMS-30LCD-4/20S is completely mis-adjusted, i.e., both potentiometers and the DIP switches are randomly set.

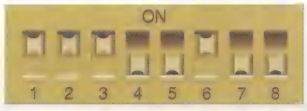
1. Set R7 (full scale gain adjust) and R3 (zero/offset adjust) fully clockwise, roughly 22 turns, and place SW1-SW8 to OFF (down position).
2. Set SW1 to ON (up position). See DIP switch setting #3.
3. Apply a precision 4mA input, with proper polarity, and adjust R3 until the meter's display reads "000".
4. Apply a precision 20mA input and adjust R7 until the meter's display reads "1999". Repeat steps 3 and 4 to make sure the adjustments do not affect one another.
5. Select the appropriate decimal point by setting SW5, SW6 or SW7 to ON (DP1, DP2 or DP3 respectively).

   NOTE: If a display reading other than "000" to "1999" is desired, refer to DIP-Switch Settings Table for SW1-SW4 settings.

Examples

1. Desired display readings are:

   4mA ="0.00"
   20mA = "2.00"



   Use DIP-switch setting #1 and enable decimal point DP2 via SW6. Apply 4mA and adjust R3 so the display reads "0.00". Apply 20mA and adjust R7 so the display reads "2.00".

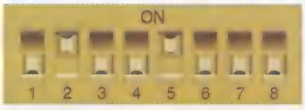
2. Desired display readings are:

   4mA =" –100"
   12mA = "000"
   20mA = "100"

   Use DIP-switch setting #4. Apply 12mA and adjust R3 so the display reads "000". Apply 20mA and adjust R7 so the display reads "100". Apply 4mA and the display should read "–100". For these display readings, no decimal points are used. Set SW5, SW6 and SW7 to OFF (down position).

3. Desired display readings are:

   4mA = ".000"
   12mA = ".250"



   This example is not as straightforward as the previous two. Notice that 12mA is exactly halfway between 4mA and 20mA. If we assume the input could go up to 20mA, the display reading would be: 2 x .250 or ".500". From the table, we can select DIP-switch setting #2 and enable DP1 via SW5. Apply 4mA and adjust R3 so the display reads ".000". Apply 12mA and adjust R7 so the display reads ".250".

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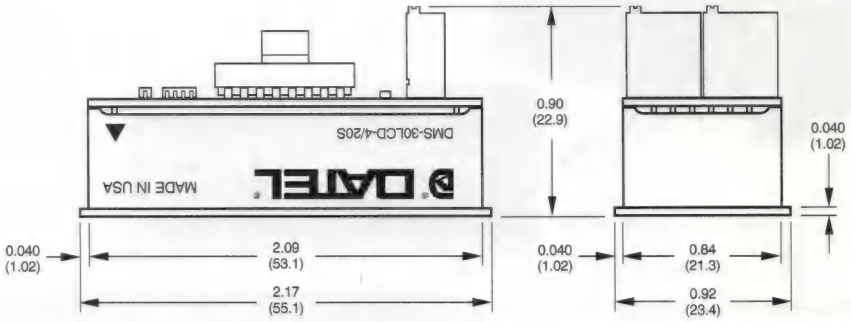
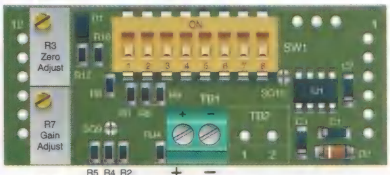
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

TOLERANCES:	2 PL DEC ±0.02 (±0.51) 3 PL DEC ±0.010 (±0.254)
WIRE SIZE:	18 to 26 AWG (Solid or stranded)
STRIPPING LENGTH:	0.20" (5.08mm)

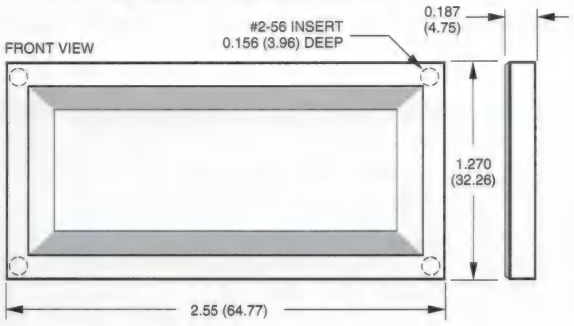


Back View

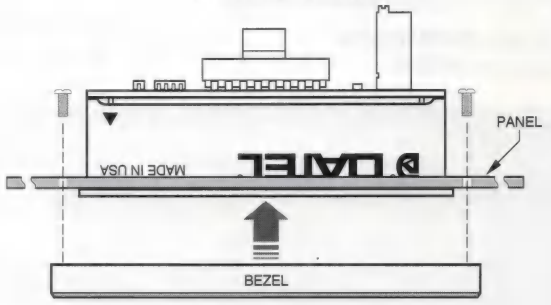


Front View

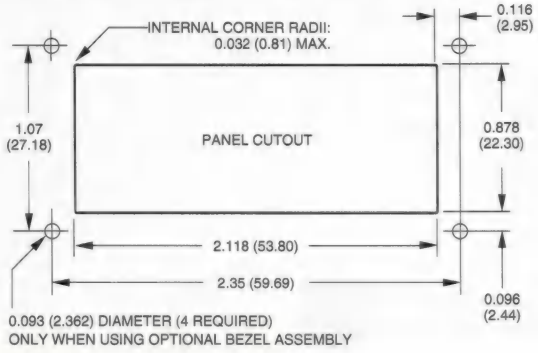
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



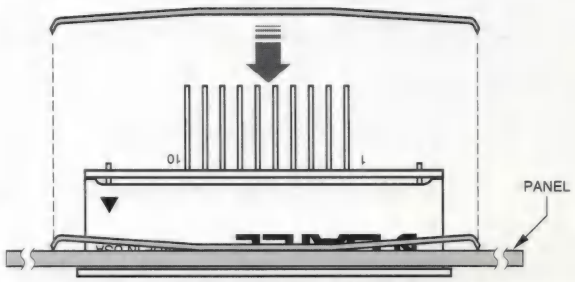
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS

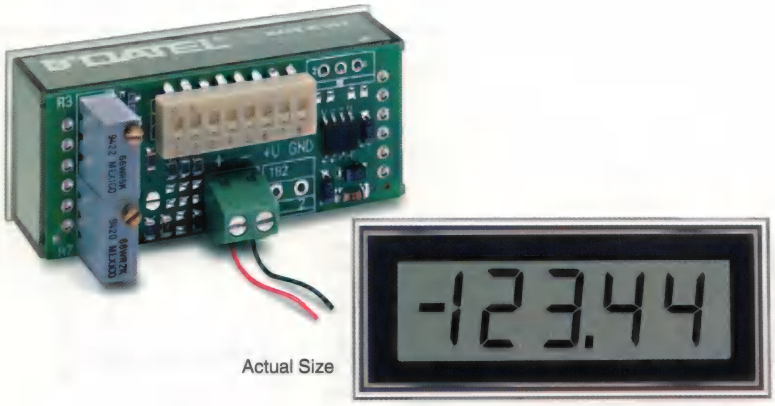


RETAINING CLIP INSTALLATION



A panel-mount retaining clip is supplied with all models

DS-0303 Rev. B



Available 2nd Quarter 1998

DMS-40LCD-4/20S

4-20mA, Low-Loop-Drop 4½ Digit, Loop-Powered LCD Meter

Preliminary Information

Features

- 2.5V max. loop drop
- Scientific-grade accuracy, ±4 counts
- Loop-powered; no external supply required
- Subminiature size:
  2.17" x 0.92" x 0.90"
  55mm x 23mm x 23mm
- Large (0.4"/10.2mm), enhanced-contrast, LCD display
- On-board gain (span) and offset (zero) adjustments
- DIP-switch selectable range and decimal points
- Rugged, vibration-resistant package
- Reliable, screw-terminal input connections

The 4½ digit member of DATEL's DMS-20/30/40LCD-4/20S Family of loop-powered, LCD-display local readouts delivers unprecedented resolution and accuracy. These are the highest-performing, easiest-to-use products of their type. All necessary operating power is derived solely from the 4-20mA current loop with absolutely no external power supplies or support components required. All gain (span) and offset (zero) adjustments are accomplished with on-board, precision, 20-turn potentiometers. All decimal-point and range-change selections are made on an easy-to-use DIP switch featuring vibration and corrosion-resistant, gold-plated contacts. Virtually any input-current/output-readout combination can be achieved.

There are no cumbersome jumpers or solder gaps to contend with. Connections to the loop are made via reliable, two-position, screw-type, terminal blocks. The only assembly tool required is a screwdriver!

The DMS-40LCD-4/20S consists of DATEL's super-reliable, epoxy-encapsulated DMS-40LCD panel meter and a 4-20mA adapter board. The entire assembly features 100% soldered connections and delivers a level of long-term reliability not available in competing products costing two to three times as much.

An optional bezel assembly, featuring screw fasteners and an EPDM rubber gasket, is available for panel-mount applications requiring increased resistance to environmental dust and moisture.

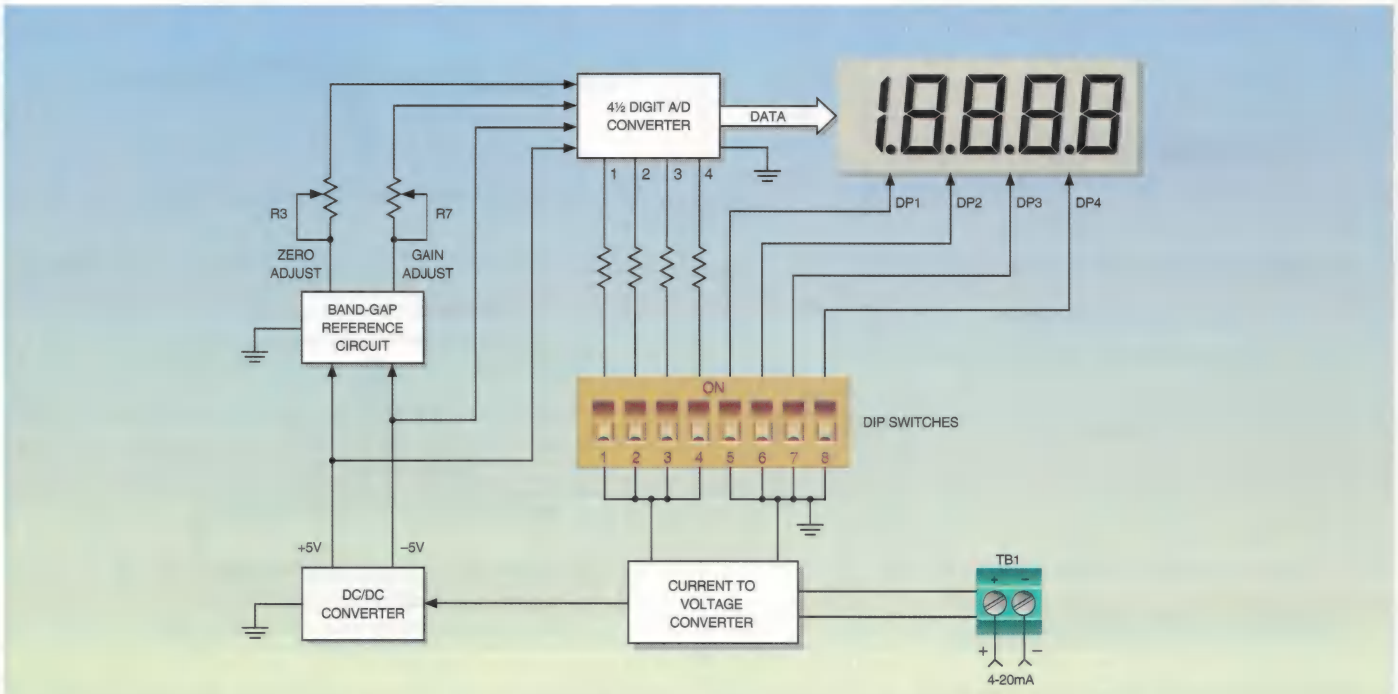


Figure 1. DMS-40LCD-4/20S Simplified Schematic

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com

Preliminary Information

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Current Loop Input	Min.	Typ.	Max.	Units
Full Scale Input Range ①	+4	—	+20	mA
Input Impedance	—	—	625	Ω
Voltage Drop	—	—	2.5	Volts
Overcurrent Protection ①	—	—	±40	mA
Performance				
Sampling Rate	2.5 readings per second			
Accuracy (3 minute warm-up)	±0.02%FS ±1 Count			
Temperature Drift (0 to +50°C)	—	±0.6	±0.8	Cnts/°C
Display				
Display Type and Size	4½ Digit LCD, 0.40"/10.2mm high			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–1____" for negative inputs "1____" for positive inputs			
Physical/Environmental				
Operating Temperature	0	—	+50	°C
Storage Temperature	–20	—	+75	°C
Humidity (Non-condensing)	0	—	95	%
Case Material	Polycarbonate			
Weight	1.0 ounces (28 grams)			

DIP-Switch Settings Table ②

Display Reading	SW1	SW2	SW3	SW4
1. 0000 to 1000-3000	On	On	On	Off
2. 0000 to 4000-6000	Off	On	Off	Off
3. 0000 to 7000-19999	On	Off	Off	Off
4. ±1000	On	On	On	Off
5. ±2000 to ±3000	On	On	Off	Off
6. ±4000 to ±6000	On	Off	Off	Off
7. ±7000 to ±19000	Off	Off	Off	On

① The DMS-40LCD-4/20S, using any of the DIP-switch settings described above, can withstand overcurrents, including those resulting from accidental reverse-polarity connections, up to ±40mA without sustaining any damage.

② When looking up DIP-switch settings in the Table and the desired display readings can be achieved with either of two different switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-40LCD standard meter (from which the DMS-40LCD-4/20S is derived) has an accuracy specification of ±3 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Ordering Information

DMS-40LCD-4/20S	4½ digit, LCD, current-loop meter
DMS-BZL1	Optional bezel assembly
DMS-BZL2	Optional bezel assembly with sealing gasket
DMS-30-CP	Panel cutout punch

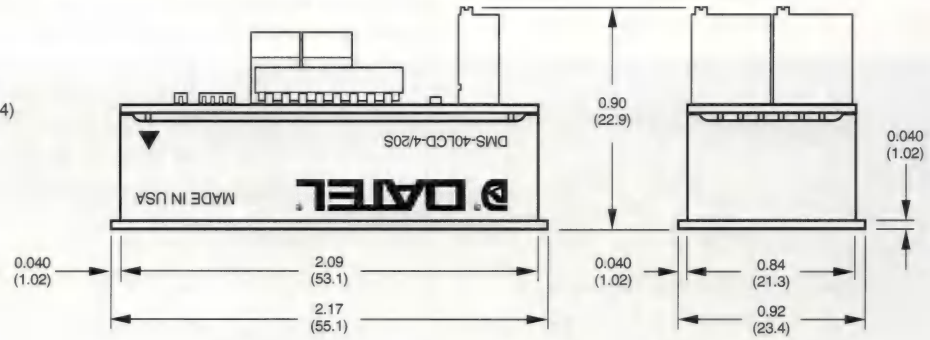
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)

WIRE SIZE: 18 to 26 AWG
(Solid or stranded)

STRIPPING LENGTH: 0.20" (5.08mm)

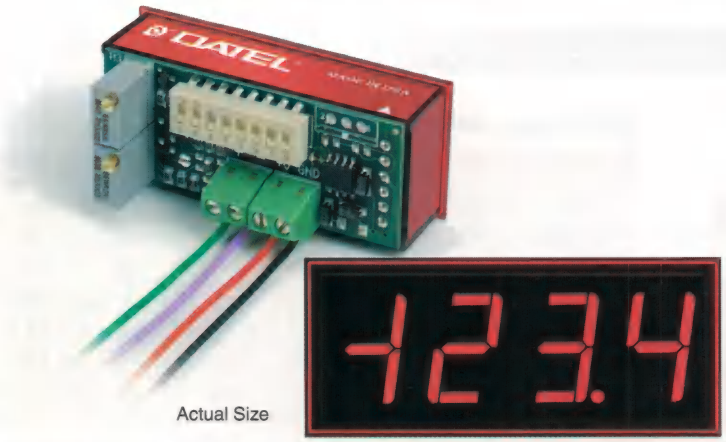


Front View

DP1 (SW5) DP2 (SW6) DP3 (SW7) DP4 (SW8)

DS-0401 Preliminary

DATEL
INNOVATION and EXCELLENCE



Actual Size

DMS-30PC-4/20S

4-20mA Input 3½ Digit Panel Meters with Full-Size LED Displays

Features

- Full-size, 0.56" (14.2mm), red or green LED's
- Low-power or high-intensity LED's optional
- Single +5V or optional +7.5-32V supply
- Low power consumption, 15mA from +5V
- 100Ω impedance, 2V loop drop
- DIP-switch selectable range and decimal points
- Hundreds of different input/readout combinations
- Vibration-resistant package; Reliable screw-terminal input connections
- High-quality, 20-turn, gain/span and zero/offset adjust potentiometers
- Miniature size: 2.17" x 0.92" x 1.08" 55mm x 23mm x 27mm

The DMS-30PC-4/20S Series of 4-20mA current-loop-input, 3½ digit, LED display panel meters offer an outstanding combination of electrical performance, display readability, ease-of-use, and long-term reliability. Each of the 5 models features a large (0.56"/14.2mm), red or green, LED display. Low-power or high-intensity red models are optional. Power supplies can be a single +5V or an optional, wide-range +7.5-32V (24V nominal). All DMS-30PC-4/20S meters are constructed using DATEL's super-reliable, field-proven, epoxy-encapsulated DMS-30PC digital voltmeters. The entire assembly utilizes 100% soldered connections. These are the most rugged, 4-20mA input, panel meters in the world.

Gain (span) and offset (zero) adjustments are both performed with high-precision, 20-turn potentiometers. All decimal point and range-change settings are made on a gold-plated, vibration-resistant, DIP switch; there are no cumbersome solder gaps or jumpers to contend with. Connections to the current loop and the power source are both made on a rugged, four-position, screw-type terminal block.

The DMS-30PC-4/20S's user-friendly design accommodates virtually hundreds of different input-current/output-reading combinations. This eliminates the majority of requirements for more costly, long-lead-time, factory "specials"–especially in applications requiring several different-range meters. A bezel assembly, featuring secure screw fasteners and an EPDM rubber gasket, is available for applications requiring moisture and/or dust resistance.

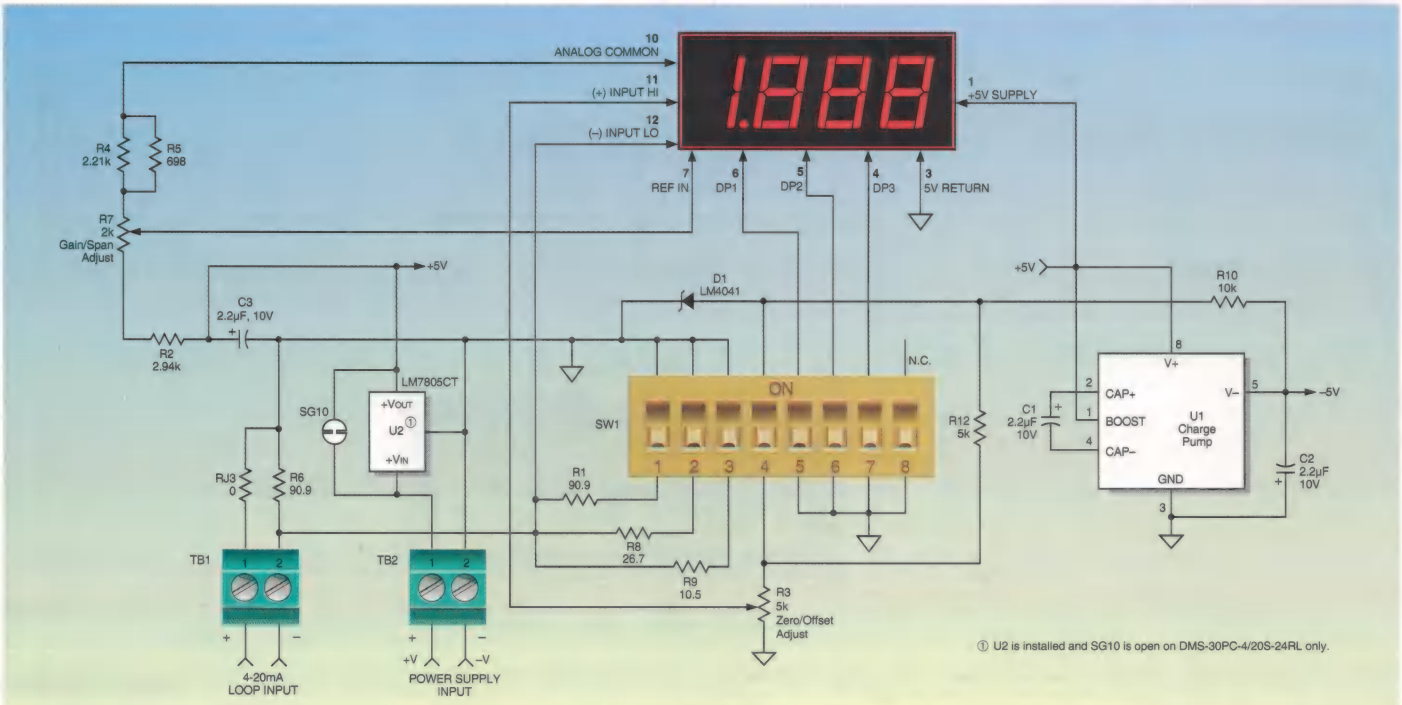


Figure 1. DMS-30PC-4/20S Simplified Schematic

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Current Loop Input	Min.	Typ.	Max.	Units
Full Scale Input Range	+3.5	--	+22	mA
Input Impedance	--	100	--	Ω
Voltage Drop	--	--	2.0	Volts
Overcurrent Protection	--	--	±40	mA
Performance				
Sampling Rate	2.5 readings per second			
Accuracy (1 minute warm-up)	±0.05%FS ±1 Count			
Temperature Drift (0 to +60°C)	--	±0.15	±0.3	Cnts/°C
Power Supply Requirements ①				
DMS-30PC-4/20S-5RS	+4.75 to +5.25Vdc at 225mA max.			
DMS-30PC-4/20S-5GS	+4.75 to +5.25Vdc at 225mA max.			
DMS-30PC-4/20S-5RH	+4.75 to +5.25Vdc at 225mA max.			
DMS-30PC-4/20S-5RL	+4.75 to +5.25Vdc at 20mA max.			
DMS-30PC-4/20S-24RL	+7.5 to +32Vdc at 30mA max.			
Display				
Display Type and Size	3½ digit LED, 0.56"/14.2mm high			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–1___" for negative inputs "1___" for positive inputs			
Physical/Environmental				
Operating Temperature	0	--	+60	°C
Storage Temperature	–40	--	+75	°C
Humidity (Non-condensing)	0	--	95	%
Case Material	Polycarbonate			
Weight	1 ounce (28 grams)			

DIP-Switch Settings Table ②

Display Reading	SW1	SW2	SW3	SW4
1. 000 to 100-300	On	On	On	Off
2. 000 to 400-600	Off	On	Off	Off
3. 000 to 700-1999	On	Off	Off	Off
4. ±100	On	On	On	Off
5. ±200 to ±300	On	On	Off	Off
6. ±400 to ±600	On	Off	Off	Off
7. ±700 to ±1900	Off	Off	Off	On

① 4-20mA applications which use a single supply (typically 12 or 24V) to power *both* the 4-20mA loop transmitter *and* the DMS-30PC-4/20S may encounter difficulties if the transmitter's current output is "single ended". Problems will occur if the current source is referenced to the same power supply ground/return to which the meter's "–V" terminal is connected. In these instances, a separate, isolated power supply should be used to power the DMS-30PC-4/20S.

② When looking up DIP-switch settings in the Table and the desired display readings happen to fall between two switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-30PC meter (from which the DMS-30PC-4/20S is derived) has an accuracy specification of ±2 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Operating and Setup Instructions

As shipped, the DMS-30PC-4/20S is factory calibrated to read "000" for a 4mA input and "1999" for a 20mA input. The following worst-case procedure assumes the DMS-30PC-4/20S is completely mis-adjusted, i.e., both potentiometers and the DIP switches are randomly set.

1. Set R7 (gain/span adjust) and R3 (zero/offset adjust) fully clockwise, roughly 20 turns, and place SW1-SW8 to OFF (down position).
2. Set SW1 to ON (up position). See DIP switch setting #3.
3. Apply a precision 4mA input, with proper polarity, and adjust R3 until the meter's display reads "000".
4. Apply a precision 20mA and adjust R7 until the display reads "1999". Repeat 3 and 4 to make sure adjustments do not affect one another.
5. If desired, select the appropriate decimal point by setting either SW5, SW6 or SW7 to ON (DP1, DP2 or DP3 respectively).

   NOTE: If a display reading other than "000" to "1999" is desired, refer to the DIP-Switch Settings Table for SW1-SW4 settings.

Ordering Information

DMS-30PC-4/20S-5RS	+5V supply, standard-intensity red LED's
DMS-30PC-4/20S-5GS	+5V supply, standard-intensity green LED's
DMS-30PC-4/20S-5RL	+5V supply, low-power red LED's
DMS-30PC-4/20S-5RH	+5V supply, high-intensity red LED's
DMS-30PC-4/20S-24RL	+7.5V to +32V supply, low-power red LED's
DMS-BZL1	Panel-mount bezel assembly
DMS-BZL2	Panel-mount bezel with sealing gasket
DMS-30-CP	Panel cutout punch

A panel-mount retaining clip is supplied with each model.

Examples

1. Desired display readings are:

   4mA ="0.00"
   20mA = "2.00"

   Use DIP-switch setting #1 and enable decimal point DP2 via SW6. Apply 4mA and adjust R3 so the display reads "0.00". Apply 20mA and adjust R7 so the display reads "2.00".

2. Desired display readings are:

   4mA = "–100"
   12mA = "000"
   20mA = "100"

   Use DIP-switch setting #4. Apply 12mA and adjust R3 so the display reads "000". Apply 20mA and adjust R7 so the display reads "100". Apply 4mA and the display should read "–100". For these display readings, no decimal points are used. Set SW5, SW6 and SW7 to OFF.

3. Desired display readings are:

   4mA = ".000"
   12mA = ".250"

   This example is not as straightforward as the previous two. Notice that 12mA is exactly halfway between 4mA and 20mA. If we assume the input could go up to 20mA, the display reading would be: 2 x .250 or ".500". From the table, we can select DIP-switch setting #2 and enable DP1 via SW5. Apply 4mA and adjust R3 so the display reads ".000". Apply 12mA and adjust R7 so the display reads ".250".

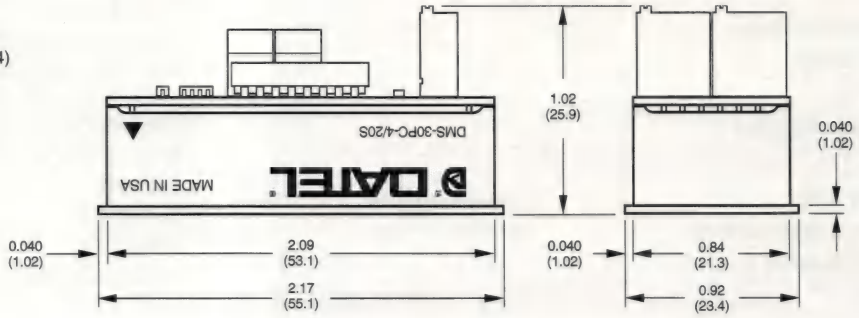
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

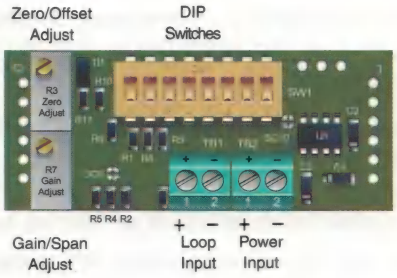
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)

WIRE SIZE: 18 to 26 AWG
(Solid or stranded)

STRIPPING LENGTH: 0.20" (5.08mm)

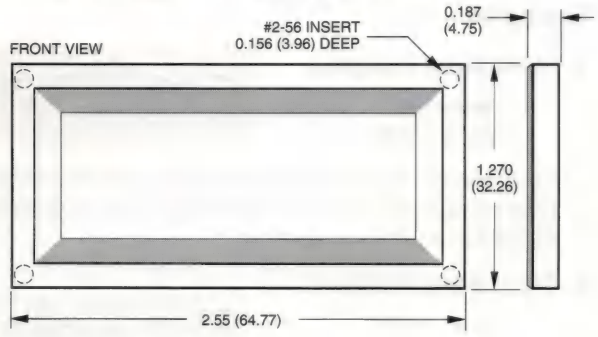


Back View

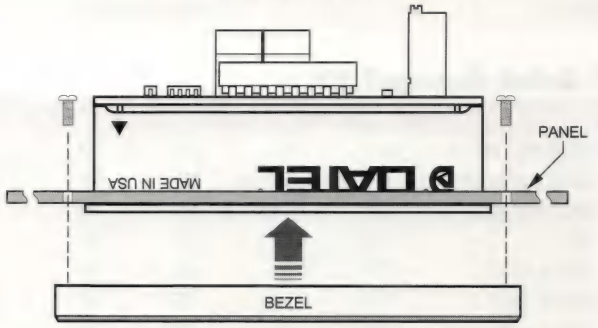


Front View

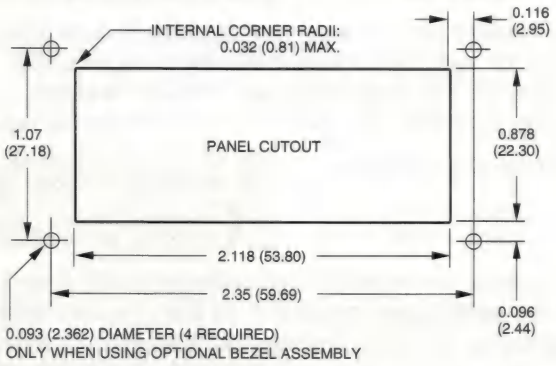
OPTIONAL BEZEL (DMS-BZL1 and DMS-BZL2)



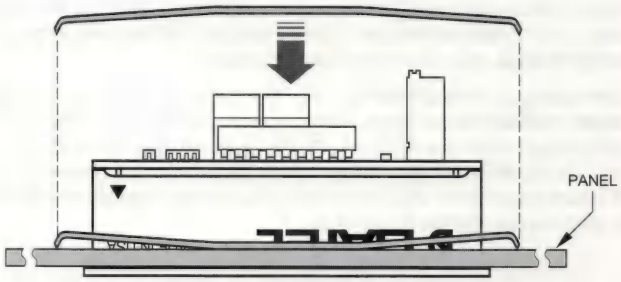
BEZEL INSTALLATION



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



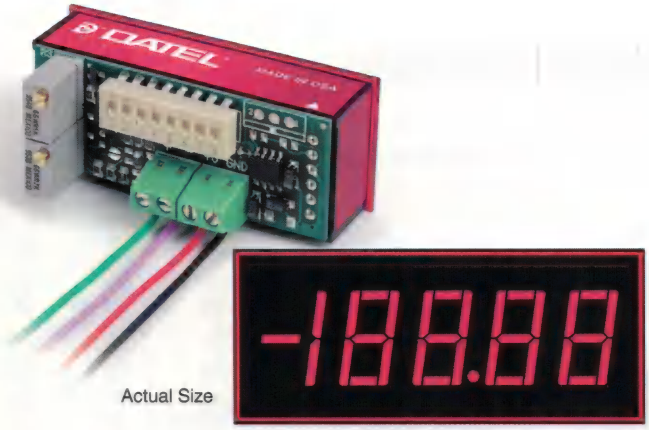
RETAINING CLIP INSTALLATION



A panel-mount retaining clip is supplied with all models

DS-0337 Rev. A

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (USA)
Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com



Actual Size

Available 2nd Quarter 1998

DMS-40PC-4/20S

4-20mA Input 4½ Digit Panel Meters with Full-Size LED Displays

Preliminary Information

Features

- Full-size (0.52"/13.2mm) red or green LED's
- Scientific-grade accuracy, ±4 counts
- 2V max. loop drop
- Single +5V or optional +7.5-28V supply
- Low-power models optional
- Subminiature size:
  2.17" x 0.92" x 1.02"
  55mm x 23mm x 26mm
- On-board gain (span) and offset (zero) adjustments
- DIP-switch selectable range and decimal points
- Hundreds of different input/readout combinations
- Reliable, screw-terminal input connections

4½ digit resolution, scientific-grade accuracy, full-size (0.52"/13.2mm) LED displays, miniature packages, and surprising affordability combine to establish the DMS-40PC-4/20S Family as the undisputed performance leaders in 4-20mA local readouts. Optional display colors include red, green, high-intensity red and low-power red (which is just as bright as other manufacturers' standard red meters). Power supplies can be a single +5V or an optional, wide-range +7.5-28V (24V nominal).

Gain and offset adjustments are performed with on-board, precision potentiometers. All decimal-point and range-change selections are made on an easy-to-use DIP switch featuring gold-plated contacts. Virtually any input-current/output-readout combination can be achieved.

The DMS-40PC-4/20S consists of DATEL's super-reliable, epoxy-encapsulated DMS-40PC LED-display, 4½ digit panel meter and a 4-20mA adapter board. The entire assembly features 100% soldered connections. There are no cumbersome jumpers or solder gaps to contend with. All connections are made via reliable, screw-type terminal blocks. The only assembly tool required is a screwdriver!

An optional bezel assembly, featuring screw fasteners and an EPDM rubber gasket, is available for panel-mount applications requiring increased resistance to environmental dust and moisture.

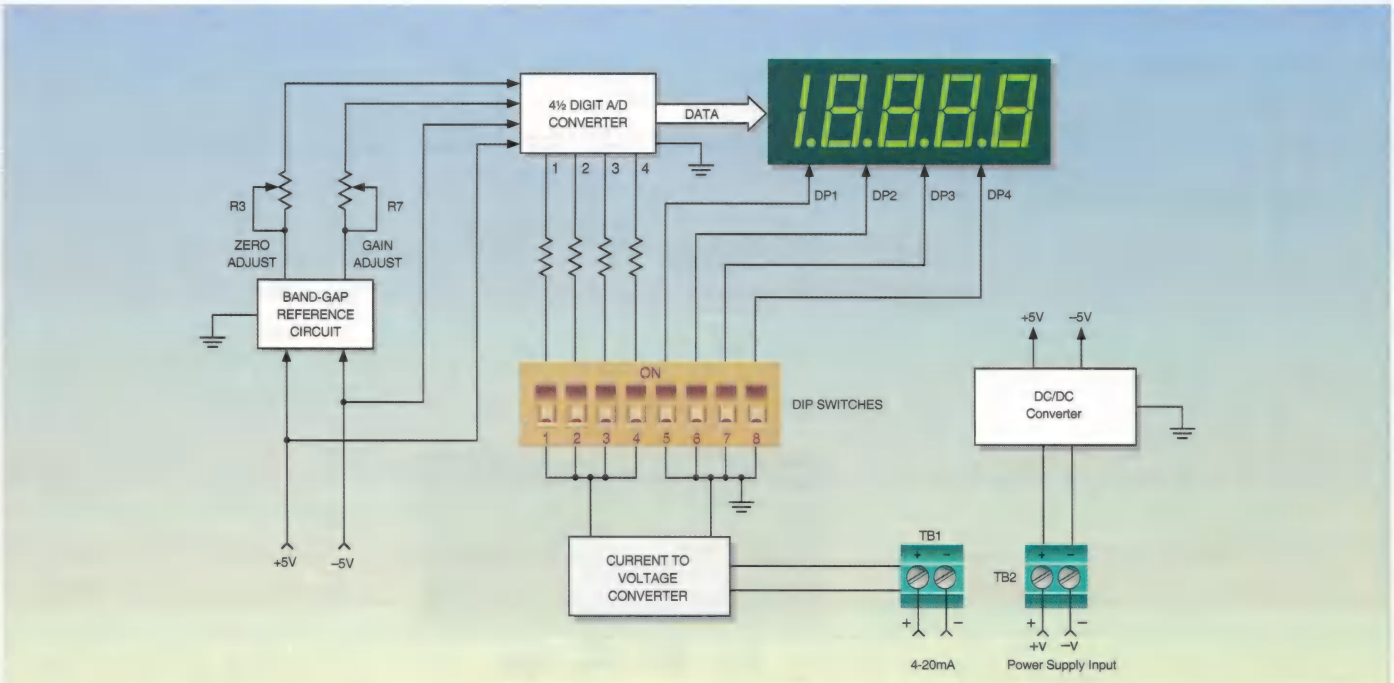


Figure 1. DMS-40PC-4/20S Simplified Schematic

Preliminary Information

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Current Loop Input	Min.	Typ.	Max.	Units
Full Scale Input Range ①	+3.5	—	+22	mA
Input Impedance	—	—	100	Ω
Voltage Drop	—	—	2.0	Volts
Overcurrent Protection ①	—	—	±40	mA
Performance				
Sampling Rate	2.5 readings per second			
Accuracy (15 minute warm-up)	±0.02%FS ±1 Count			
Temperature Drift (0 to +50°C)	—	±0.6	±0.8	Cnts/°C
Display				
Display Type and Size	4½ Digit LED, 0.52"/13.2mm high			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–0000" (flashing) for negative inputs "0000" (flashing) for positive inputs			
Physical/Environmental				
Operating Temperature	0	—	+50	°C
Storage Temperature	–20	—	+75	°C
Humidity (Non-condensing)	0	—	95	%
Case Material	Polycarbonate			
Weight	1.0 ounces (28 grams)			

① The DMS-40PC-4/20S, using any of the DIP-switch settings described above, can withstand overcurrents, including those resulting from accidental reverse-polarity connections, up to ±40mA without sustaining any damage.

DIP-Switch Settings Table ②

Display Reading	SW1	SW2	SW3	SW4
1. 0000 to 1000-3000	On	On	On	Off
2. 0000 to 4000-6000	Off	On	Off	Off
3. 0000 to 7000-19999	On	Off	Off	Off
4. ±1000	On	On	On	Off
5. ±2000 to ±3000	On	On	Off	Off
6. ±4000 to ±6000	On	Off	Off	Off
7. ±7000 to ±19000	Off	Off	Off	On

② When looking up DIP-switch settings in the Table and the desired display readings can be achieved with either of two different switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-40PC standard meter (from which the DMS-40PC-4/20S is derived) has an accuracy specification of ±3 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Ordering Information

DMS-40PC-4/20S-5RS	+5V supply, standard-intensity red LED's
DMS-40PC-4/20S-5GS	+5V supply, standard-intensity green LED's
DMS-40PC-4/20S-5RL	+5V supply, low-power red LED's
DMS-40PC-4/20S-5RH	+5V supply, high-intensity red LED's
DMS-40PC-4/20S-24RL	+7.5V to +28V supply, low-power red LED's
DMS-BZL1	Optional panel-mount bezel assembly
DMS-BZL2	Optional panel-mount bezel assembly with sealing gasket
DMS-30-CP	Panel cutout punch

A panel-mount retaining clip is supplied with each model.

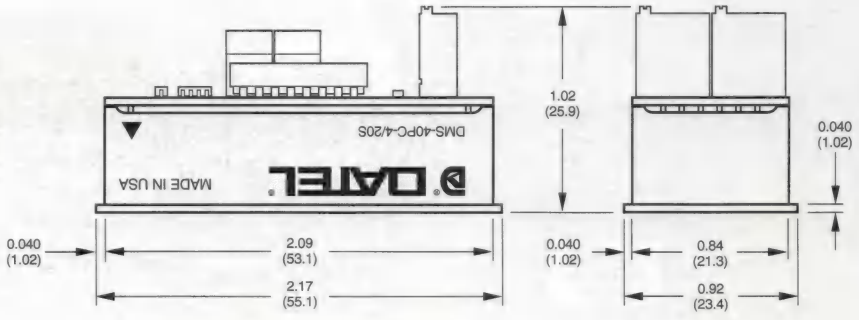
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)

WIRE SIZE: 18 to 26 AWG (Solid or stranded)

STRIPPING LENGTH: 0.20" (5.08mm)



Front View

DP1 (SW5) DP2 (SW6) DP3 (SW7) DP4 (SW8)

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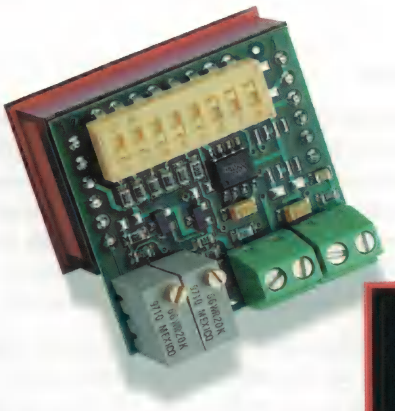

Actual Size

DMS-20PC-0/5

0-5V and 0-10V Input 3½ Digit, LED Display Process Control Monitors

Features

- Accepts 0-5V and 0-10V inputs
- Large, easy-to-read, 0.37"/9.4mm LED display
- Choice of 5 LED power/color options
- High input impedance, 100kΩ
- +5V to +40V model draws 9mA typ.
- Miniature size: 1.38" x 1.25" x 0.95"
- High-quality, 20-turn, span (gain) and zero (offset) adjustments
- DIP-switch selectable range and decimal points
- Vibration-resistant package; Reliable screw-terminal input connections
- Hundreds of different input/readout combinations

DATEL's DMS-20PC-0/5 Series are the world's smallest, full-featured, 0-5V input process control monitors. Their large, easy-to-read, 0.37"/9.4mm LED displays are available in a choice of 4 LED color/intensity options: standard red, standard green, super-bright red, and low-power red. Two power supply input ranges are also available: the industry-standard +5V and a wide-range +5V to +40V (which typically draws 9mA at +24V).

Gain (span) and offset (zero) adjustments are performed with on-board, precision, 20-turn potentiometers. All decimal-point and range-change selections are made on an 8-position, vibration-resistant, gold-plated DIP switch. Unlike competitive meters, there are no jumpers or solder gaps to open or close, and to further enhance reliability, the entire assembly utilizes 100% soldered connections. Both power-supply and input-signal connections are made via reliable screw-type terminal blocks.

The DMS-20PC-0/5's DIP switch and potentiometers accommodate hundreds of input-voltage/output-reading combinations. This practically eliminates the need for more costly, long-lead-time, factory "specials" in applications which use several different-range meters. An accessory bezel assembly—featuring metal fasteners and a rubber gasket—simplifies panel mounting and also provides excellent resistance to environmental dust and moisture. All these outstanding features combine to make the DMS-20PC-0/5 the perfect meter for prototype and OEM, 0-5V input, process control monitoring.

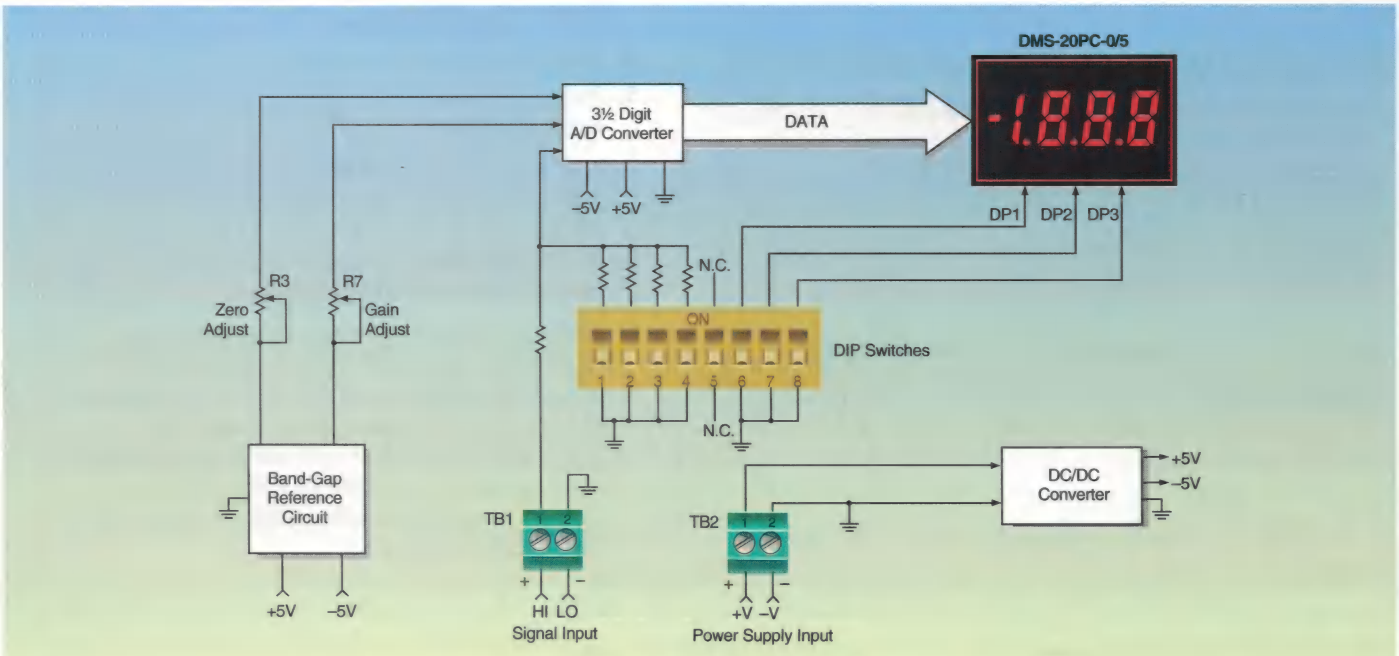

Figure 1. DMS-20PC-0/5 Simplified Schematic

Performance/Functional Specifications

Typical at T_A = +25°C, unless otherwise noted.

Input	Min.	Typ.	Max.	Units
Full Scale Input Range ①	4.9	5.0	5.1	Volts
Input Impedance	100	–	140	kΩ
Overcurrent Protection ①	–	–	±40	Volts
Performance				
Sampling Rate	2.5 samples per second			
Accuracy (1 minute warm-up)	±0.05%FS ±1 Count			
Temperature Drift (0 to +60°C)	—	±0.15	±0.3	Cnts/°C
Display				
Display Type and Size	3½ Digit LED, 0.37"/9.4mm high			
Polarity Indication	"–" for negative readings			
Overrange Indication	"–1___" for negative inputs "1___" for positive inputs			
Physical/Environmental				
Operating Temperature	0	—	+60	°C
Storage Temperature	–40	—	+75	°C
Humidity (Non-condensing)	0	—	95	%
Case Material	Polycarbonate			
Weight	0.6 ounces (17 grams)			
Power Supply Requirements				
DMS-20PC-0/5-5RS	+4.75V to +5.25V at 90mA max.			
DMS-20PC-0/5-5GS	+4.75V to +5.25V at 120mA max.			
DMS-20PC-0/5-5RL	+4.75V to +5.25V at 15mA max.			
DMS-20PC-0/5-5RH	+4.75V to +5.25V at 90mA max.			
DMS-20PC-0/5-24RL	+4.75V to +40V at 15mA max.			

① The DMS-20PC-0/5 can also be used in most 0-10V applications. See the section on 0-10V inputs for more information. See Note 3 on Table 1.
② INPUT LO (TB1 "–LO") is internally connected to the power return (TB2 "–V"). Overvoltage specifications apply to the INPUT HI (TB1 "+HI") connection.

Ordering Information

DMS-20PC-0/5-5RS	+5V supply, standard-intensity red LED's
DMS-20PC-0/5-5GS	+5V supply, standard-intensity green LED's
DMS-20PC-0/5-5RL	+5V supply, low-power red LED's
DMS-20PC-0/5-5RH	+5V supply, high-intensity red LED's
DMS-20PC-0/5-24RL	+5V to +40V supply, low-power red LED's
DMS-BZL3	Bezel assembly
DMS-BZL4	Bezel assembly with sealing gasket
DMS-20-CP	Panel cutout punch

Note: Standard panel-mount applications MUST use either DMS-BZL3 or DMS-BZL4 bezel assemblies. See Mechanical Specifications section for cutout/drill dimensions.

Technical Notes

1. **Input Configuration:** The DMS-20PC-0/5 has its input low terminal (TB1 "LO") internally connected to the power supply ground terminal (TB2 "–V"). This connection effectively places the meter's input in a single-ended configuration. In some applications, single-ended inputs can cause ground-loop induced errors (the meter's display becomes unstable or bounces). This occurs because the LED drive currents flow through both the –V terminal and the signal LO terminal.

   If suspected ground-loop errors are encountered, and the input signal LO terminal is externally connected to –V somewhere else in the system, try removing the connection to TB1 "LO". Inputs which have no ground-return connection to –V (commonly referred to as "floating inputs") must have their most negative potential tied to TB1 "LO". Please consult DATEL for more information.

   Applications which require electrical isolation between the input signal source and the system power supply must use a separate transformer-isolated supply to power the meter.

2. **Panel Mounting:** In most standard through-the-panel installations, the DMS-20PC-0/5 must be secured to the panel with either DMS-BZL3 or DMS-BZL4 optional bezel assemblies (see the Mechanical Specifications section and the Ordering Guide for more information). The metal retaining clip supplied with other DMS-20 Series meters CAN NOT be used to support the DMS-20PC-0/5.

Operating and Setup Instructions

As shipped, the DMS-20PC-0/5 is factory calibrated to read "000" for a 0.0V input and "1999" for a 5.0V input. The following worst-case procedure assumes the DMS-20PC-0/5 is completely mis-adjusted, i.e., both potentiometers and the DIP switches are randomly set.

1. Set R7 (full scale span/gain adjust) and R3 (zero/offset adjust) fully clockwise, roughly 22 turns, and place SW1-SW8 to OFF (down position).
2. Select DIP switch setting #1 in Table 1.
3. Apply a precision 0.0V input and adjust R3 until the meter's display reads "000".
4. Apply a precision 5.0V input and adjust R7 until the meter's display reads "1999". Repeat steps 3 and 4 to make sure the adjustments do not affect one another.
5. Select the appropriate decimal point by setting SW6, SW7 or SW8 to ON (DP1, DP2 or DP3 respectively).

   NOTE: The "000" to "1999" display readings referred to in the instructions above are for illustrative purposes only. If other display readings such as "000" to "1200" are desired, refer to the DIP-Switch Settings Tables for SW1-SW4 settings. (SW5 is reserved for future use, it has no affect on display operation.) The initial setting of R3 and R7 fully clockwise is recommended in the adjustment procedure for all the following examples.

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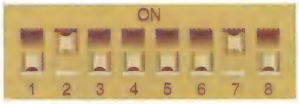
Applications

Examples (0-5V Inputs)

1. Desired display readings are:

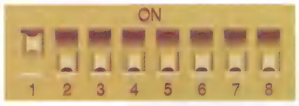
   0.0V input = "0.00"
   5.0V input = "6.00"



   Use DIP-switch setting #3 in Table 1 and enable decimal point DP2 via SW7. Apply 0.0V and adjust R3 so the display reads "0.00". Apply 5.0V and adjust R7 so the display reads "6.00".

2. Desired display readings are:

   0.0V input = "000"
   5.0V input = "800"



   Use DIP-switch setting #2 in Table 1. Apply 0.0V and adjust R3 so the display reads "000". Apply 5.0V and adjust R7 so the display reads "800". For these display readings, no decimal points are used. Set SW6, SW7 and SW8 to OFF.

3. Desired display readings are:

   0.0V input = ".000"
   5.0V input = ".250"

   Use DIP-switch setting #5 in Table 1 and enable decimal point DP1 via SW6. Apply 0.0V and adjust R3 so the display reads "000". Apply 5.0V and adjust R7 so the display reads ".250".

Table 1. 0-5V DIP-Switch Settings ③

Display Reading		SW1	SW2	SW3	SW4
0.0V Input	5.0V Input				
1. 000	1200-1999	Off	Off	Off	Off
2. 000	700-1200	On	Off	Off	Off
3. 000	400-700	Off	On	Off	Off
4. 000	300-400	Off	Off	On	Off
5. 000	190-300	Off	On	On	Off
6. 000	120-190	Off	Off	On	On
7. 000	100-150	Off	On	On	On
8. 000	90-140	On	On	On	On

③ The DMS-20PC-0/5 is optimized for handling 5V signal ranges that are positioned between –0.1V and +6.0V. As such, input ranges can be anywhere between –0.1V to +4.9V and +1.0V to +6.0V as long as their full range is 5 Volts. The meter's zero/offset potentiometer (R3) has enough adjustment range to produce a "000" display reading for input signal levels between –0.1V and +1.0V.

Please note the DMS-20PC digital panel meter from which the DMS-20PC-0/5 is derived has an accuracy specification of ±2 counts (max.). Thus, it may not always be possible to obtain the exact desired display readings.

4. Desired display readings are:

   1.0V input = "000"
   6.0V input = "090"

   Even though this input is positioned between +1.0V and +6.0V, it still meets the 5V full scale input range listed in the Functional Specifications section. Use DIP-switch setting #8 in Table 1. Apply 1.0V and adjust R3 so the display reads "000". Apply 6.0V and adjust R7 so the display reads "090". With this type of input, it is advisable to recheck both input levels to be sure the potentiometer settings do not affect one another.

0-10V Inputs

While the DMS-20PC-0/5 is optimized for operation with 0-5V inputs, its versatile input stage can also accommodate most 0-10V applications. The meter's zero/offset potentiometer (R3) has enough adjustment range to produce a "000" display reading with input signal levels between –0.1V and +1.0V. Table 2. summarizes the available ranges when the DMS-20PC-0/5 is used with 0-10V inputs.

Example (0-10V Inputs)

1. Desired display readings are:

   0.0V input = "000"
   10.0V input = "500"

   Use DIP switch setting #4 in Table 2. Apply 0.0V and adjust R3 so the display reads "000". Apply 10.0V and adjust R7 so the display reads "500".

Table 2. 0-10V DIP-Switch Settings

Display Reading		SW1	SW2	SW3	SW4
0.0V Input	10.0V Input				
1. 000	1400-1999	On	Off	Off	Off
2. 000	800-1400	Off	On	Off	Off
3. 000	600-800	Off	Off	On	Off
4. 000	380-600	Off	On	On	Off
5. 000	240-380	Off	Off	On	On
6. 000	200-300	Off	On	On	On
7. 000	180-280	On	On	On	On

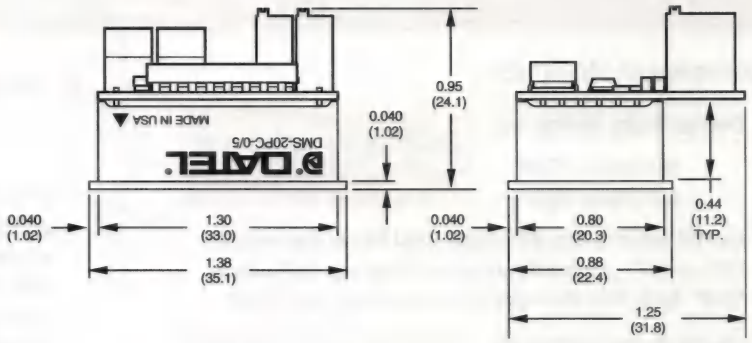
Mechanical Specifications

MECHANICAL DIMENSIONS: Inches (mm)

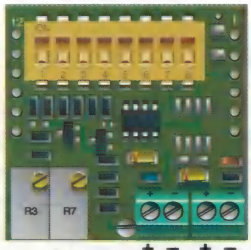
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)

WIRE SIZE: 18 to 26 AWG
(Solid or stranded)

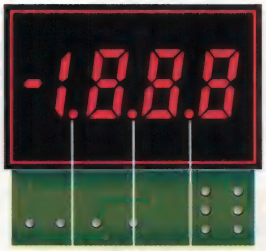
STRIPPING LENGTH: 0.20" (5.08mm)



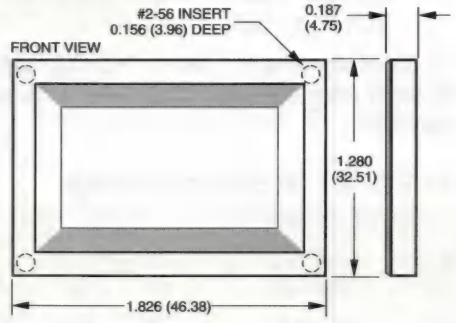
Back View



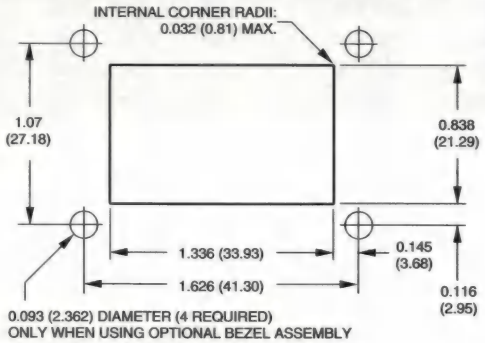
Front View



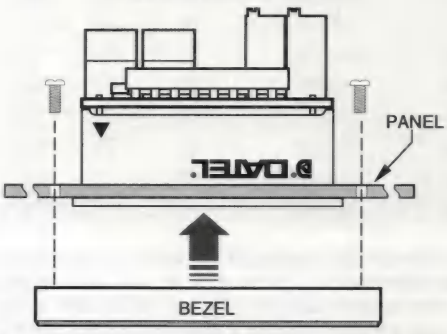
OPTIONAL BEZEL (DMS-BZL3 and DMS-BZL4)



RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS



BEZEL INSTALLATION



DS-0391 Rev. A

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Application Boards & Accessories

Turn your DMS Series Digital Panel Voltmeter into an application-specific instrument simply by soldering one of DATEL's unique EB Series Application Boards directly to the back of the meter. These rugged, low-cost boards quickly and easily configure each meter for such popular applications as: 4-20mA process monitoring, attenuating high-level input voltages, converting ac signals to rms values, accepting inputs from J/K thermocouples, operating directly from ac line power, and many others.

Application Boards incorporate mechanically reliable, screw-type terminal blocks for connecting input signals and power. On-board DIP switches and solder gaps enable users to further adapt many of the different board configurations. Pre-drilled holes for user-supplied components provide an additional level of flexibility.

For large OEM requirements, DATEL readily designs and manufactures fully guaranteed, completely pre-assembled and pre-tested, meter/board combinations to suit your unique requirements. Our standard product DMS-30LCD-4/20S Loop-Powered LCD Meter (see page 4-7) demonstrates how cost-effective this approach can be. Please contact our Sales or Applications Engineers for more information.

Table of Contents

Application Boards for DMS-20PC/LCD Meters

DMS-EB2 Multi-Purpose: 4-20mA, Input Attenuation, Gain/Offset Adjust and More 5-3

Application Boards for DMS-30PC/LCD Meters

DMS-EB Multi-Purpose: 4-20mA, Input Attenuation, Gain/Offset Adjust and More 5-6

DMS-EB-AC/DC AC/DC Converter for Operation from AC Line Voltage 5-9

DMS-EB-DC/DC DC/DC Converter for Supplies to +18V and 750V Isolation 5-10

DMS-EB-HTB Direct Inputs from AD590 Temperature Sensors 5-11

DMS-EB-LP "Loop-Powered" 4-to-20mA Measurements 5-12

DMS-EB-RMS AC-to-RMS Converter for Direct Measurement of AC Inputs 5-14

DMS-EB-TCJ/TCK Direct Inputs from J or K Type Thermocouples 5-15

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Accessories DC/DC Converters, Connectors, Terminals, Bezels, Panel Punches, More 5-16

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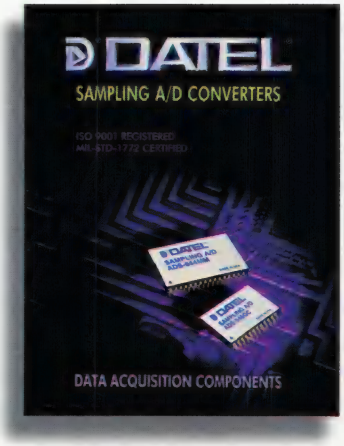

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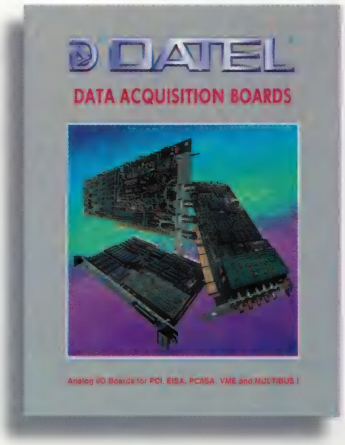

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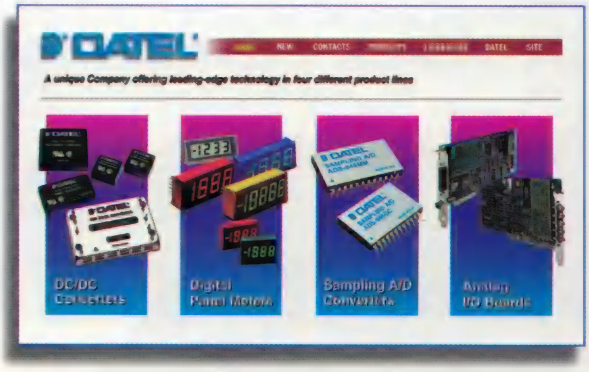

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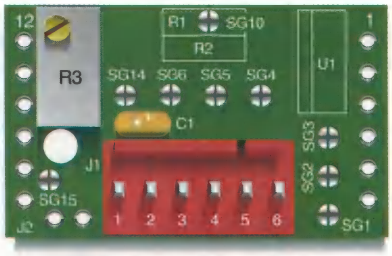


DMS-EB2

Multi-Purpose Application Board for DMS-20PC/LCD Meters

Features

- **Provisions for 4-20mA operation**
- **Gain (span) and offset (zero) adjustments**
- **Input divider network for attenuating voltages up to 250Vdc**
- **Operate meter and board from +5V supply or 9/12V battery**
- **On-board solder gaps for decimal point placement**
- **On-board I/O connector for easy power and signal input**

Functional Specifications

(TA = +25°C)

Input Supply Range
See applicable meter's data sheet

Input Supply Range U1 (LM7805CT) Installed:

DMS-20PC-X-XS	+7.5 to +12.6V
DMS-20PC-X-XL	+7.5 to +32.0V
DMS-20LCD-X-5	+7.5 to +32.0V
DMS-20LCD-X-5B	+7.5 to +12.6V

Operating and Storage Temperature
See applicable meter's data sheet

Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

J1 Connector Information

Terminal Type	DATEL P/N 39-2099090
Crimp Tool	DATEL P/N 39-2099000
Wire Size	22 to 26 AWG

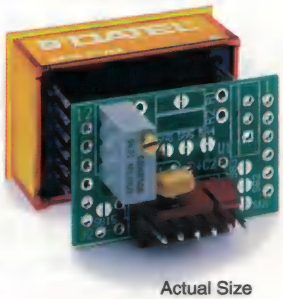
Insulation Diameter
0.062" (1.57mm) maximum

Stripping Length
0.100" to 0.125" (2.54 to 3.17mm)

Ordering Information

DMS-EB2	Application board with mating connector and terminals
DMS-BZL3	DMS-20 bezel assembly
DMS-BZL4	DMS-20 bezel assembly with sealing gasket
39-0304000	LM7805CT (U1), +5V-output, three-terminal regulator

The DMS-EB2 Application Board was designed for quick and easy application/evaluation of DATEL's subminiature DMS-20PC/LCD Series, 3½ Digit, LED/LCD Display, Digital Panel Voltmeters. The DMS-EB2's versatility, low cost and direct DMS-20PC/LCD plug-in compatibility makes interfacing a breeze. The DMS-EB2 covers many common panel-meter applications while providing easy signal and power I/O terminations (via a standard MOLEX connector) and plug-in versatility when changing from one application to another.



Actual Size

The DMS-EB2 has provisions for such common applications as input dividers for high input voltages, gain (span) and offset (zero) adjustments, 4-20mA process monitoring, 9/12Vdc battery operation, and decimal point placement. The board permits direct signal I/O wiring via the interface connector or soldering directly to the board. The DMS-EB2 is fully compatible with all four versions of the DMS-20PC/LCD (±200mV, ±2V, ±20V, ±200V) making it interchangeable from meter to meter and application to application. Solder gaps are conveniently placed on the board and may be quickly bridged or cut as required.

This low-cost addition to DATEL's expanding line of subminiature meters demonstrates our continuing commitment to offer the most versatile, easy-to-use panel-meter products.

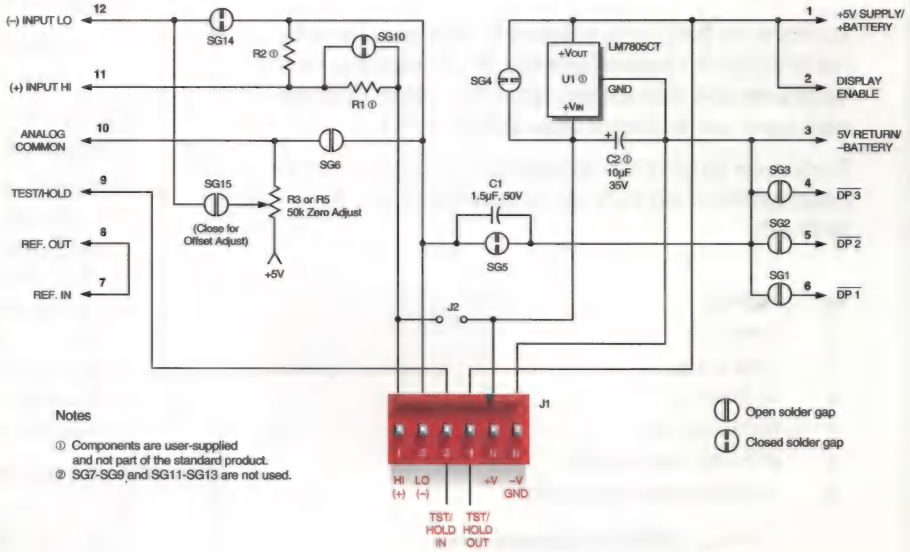


Figure 1. DMS-EB2 Schematic Diagram

DS-0340 Rev. A

Technical Notes

1. **LCD Backlighting:** To backlight a DMS-20LCD meter, connect J1, pin 3 (TEST/HOLD IN) to J1, pin 6 (GND). This allows for external control, via a switch, of the backlight feature. The switch should be rated for low voltage operation at 35mA.
2. **9V LCD Meters:** DMS-20LCD-X-9 meters cannot be used in a single-ended configuration, i.e., with (–) IN LO tied to GND. On these models, both (–) IN LO and (+) IN HI have to be a minimum of 1.5V above and 1.5V below J1 pins 6 and 5, respectively. To operate from a 9V or 12V battery with (–) IN LO tied to GND, use a 5V-powered meter (DMS-20LCD-X-5), install U1 (LM7805CT) and open SG4.
3. **Input Resistor Dividers:** Always use 1%, or better, metal-film resistors for R1 and R2, and also make sure their power and voltage ratings are adequate for the given application.
4. **Using U1 (LM7805CT):** The input power range specified in the Battery Operation section is rated conservatively assuming a 100mA LED meter or a 35mA backlit LCD meter. If a non-backlit LCD model or the low-power LED model is used, the input voltage range can be extended up to 24Vdc.

   A 10µF/35V tantalum capacitor (C2 on schematic) should be installed with the polarized end next to the + symbol on the DMS-EB2. This is especially important if the power source is located far from U1.
5. **Soldering:** DATEL recommends the use of "no-clean" solders when making modifications to the DMS-EB2.

Applications

As shipped, the DMS-EB2 is configured for single-ended operation. This configuration is preferred for simple voltage measurements and will generally cover most standard applications. Figure 1 indicates which solder gaps are shipped closed from the factory.

Simply solder the board onto the meter (pin 1 to pin 1), connect the power supply to J1, pin 5 (+V) and the power return to J1, pin 6 (GROUND).

Pin	Function
1	(+) INPUT HI
2	(–) INPUT LO
3	TEST/HOLD IN
4	TEST/HOLD OUT
5	+V (Positive power connection)
6	–V (Ground, negative power return)

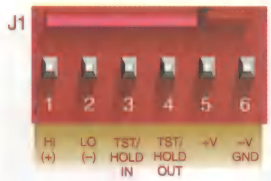


Figure 2. J1 Connector Pinout

1. **Decimal Point Placement:** DATEL ships the DMS-EB2 with all decimal point solder gaps (SG1, SG2 and SG3) open. To enable a specific decimal point, close its respective solder gap with solder. When re-assigning decimal places for subsequent applications, remember to unsolder previously closed solder gaps.

   Close SG1 for 1.999 (DP1)
   Close SG2 for 19.99 (DP2)
   Close SG3 for 199.9 (DP3)
2. **Display Test** (Not Available on LCD Models)**:** Tie pin 4 (TEST/HOLD OUT) to pin 3 (TEST/HOLD IN) to test the display of the DMS-20PC. Do not leave the meter in the test mode for more than 10 seconds. On LED meters with the HOLD option, tying pins 3 and 4 together freezes the display reading.

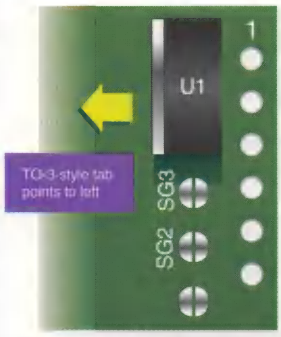


Figure 3. Installing U1

3. **Battery Operation:** Open SG4 and install U1 (LM7805CT) with its metal tab facing to the left as shown in Figure 3. Allowable input power ranges (J1, pins 5 and 6) are as follows:

   DMS-20PC-X-XS +7.5 to +12.6Vdc
   DMS-20PC-X-XL +7.5 to +24.0Vdc

   C2 (10µF/35V) can be added to reduce noise. Observe correct polarity. Refer to Technical Note 4 for more information.
4. **Calibration and Zero (Offset) Adjustment** (Refer to Figure 1): The DMS-EB2 has provisions for adjusting the calibration of the DMS-20 meter and also for applying an offset voltage to the (–) IN LO input terminal. Calibration adjustment is useful when an input divider (using R1 and R2) is necessary to scale the input voltage. The calibration potentiometer allows "tweaking" of the display reading. Zero offset adjustment can be used to compensate for an input signal whose zero level is not zero volts, as in 4-20mA current loop applications.

Using the calibration potentiometer

Adjust the calibration pot as desired. The adjustment range is only 3/4 of a turn. Do not force the pot past its end stops.

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Applications

Using the zero offset potentiometer

1. Open solder gaps SG5 and SG14.
2. Close solder gaps SG6 and SG15.
3. R5, zero offset, can now be adjusted.

NOTE: The zero offset feature can not be used with single-ended inputs, i.e., inputs for which (–) IN LO is at GND. This is the reason for opening SG5.

5. **Differential Input Signals** (Signal Referenced to Power Source): Open SG5. Apply the input signal to pin 1, (+) IN HI, and pin 2, (–) IN LO, of J1.

NOTE: Common mode voltage must not exceed ±2Vdc.

6. **Measuring Input Voltages Greater than 1.999Vdc** (Use DMS-20PC/LCD-1 Only):

CAUTION: Do not exceed 250Vdc input signal.

1. Open SG10. For applications in which input voltages exceed ±100Vdc, also cut the 2 adjoining traces.
2. Calculate values for R1 and R2 as follows:

$$R2 = (FSI \times R1) / (|V_{IN}| - FSI)$$

Where:
FSI = The attenuated voltage, between the meter's (–) IN LO and (+) IN HI pins, needed to achieve the desired display readings

V_{IN} = Input voltage at J1 (beween pins 1 and 2)

A typical value for R1 is 1MΩ. The sum of R1 + R2 should be between 50kΩ and 10MΩ.

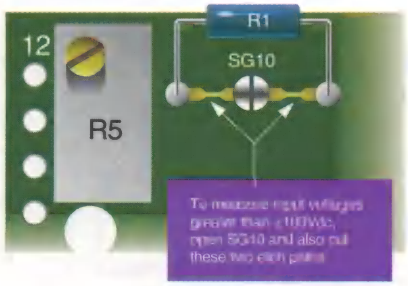

Figure 4. Installing R1

Example

V_{IN} is 199.9Vdc, and the display reading must be "199.9".

1. Assume R1 = 1.0MΩ.
2. R2 = (FSI x R1) / (|V_{IN}| - FSI)
   R2 = (1.999 x 1,000,000) / (199.9 - 1.999)
   R2 = 10101.01Ω or 10kΩ
3. Enable DP3 by soldering SG3.
4. Calibrate the meter using a known voltage source. Adjust the internal gain potentiometer to compensate for variations in R1 and R2.

7. **4-20 mA Current Loop Operation** (Recommended Use for 2V Model, DMS-20PC/LCD-1):

1. Install R2 (R2 = FSR / 0.016) where FSR is the desired meter reading in volts.
2. Open SG5 and SG14.
3. Close SG6 and SG15.
4. Close SG10 (if open).
5. Apply 4mA, adjust R5 for zero offset.
6. Apply 20mA, adjust internal gain pot for full range span.
7. Check span and zero and readjust for best readings.

NOTE: Provide isolated 5Vdc power source.

8. **Current Measurements** (Use 200mV Model, DMS-20PC/LCD-0): The following instructions are for measuring current derived from the DMS-20PC/LCD's power source. When measuring current that is floating with respect to J1, pin 6 (GROUND), leave SG5 closed.

CAUTION: Do not exceed 1 Ampere input current.

1. Install R2 (R2 = FSR / (I_{MAX} x 10000)) where FSR is the desired reading (0-1999) and I_{MAX} is between 0-1 Ampere.
2. Open SG5.
3. Apply input signal (current) to (+)IN HI and (–) IN LO.
4. Adjust internal gain pot for desired full scale readings.
5. Enable decimal points using either SG1, SG2 or SG3.

Example

A 1.0 Ampere input must read "1.000" on the display.

R2 = 1000 / (1 x 10000)
R2 = 0.1 Ohm
Enable DP1 via SG1 for reading of 1.000

9. **Displaying DMS-20PC/LCD's Power Source** (Use DMS-20PC/LCD-2, 5V-Powered Models Only):

1. If the power source is higher than 5Vdc, be sure to install U1 and cut SG4. See Battery Operation section and Technical Note 4.
2. Solder a short piece of jumper wire across the two holes labeled J2.
3. Close SG2 to enable DP2.

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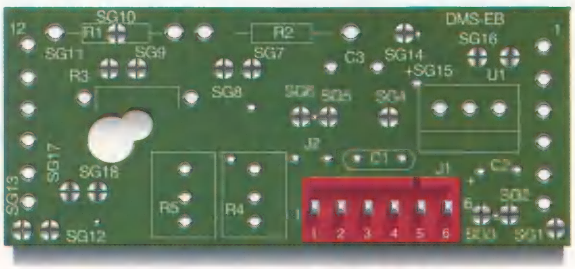


DMS-EB

Multi-Purpose Application Board for DMS-30 & DMS-40 Series Meters

Features

- **Accommodates 3½ and 4½ digit meters**
- **Gain (span) and offset (zero) adjustments for DMS-30 meters**
- **Input divider network for high voltages**
- **Operate meter and board from +5V supply or 9/12V battery**
- **Solder gaps for decimal placement**
- **Same size as DMS-30/40 Series meters 2.02" (51.31mm)L x 0.83" (21.08mm)W**

Functional Specifications

(TA = +25°C)

Input Supply Range
See applicable meter's data sheet

Input Supply Range U1 (LM7805CT) Installed:

DMS-30/40PC-X-XS	+7.5 to +12.6V
DMS-30/40PC-X-XL	+7.5 to +18.0V
DMS-30/40LCD-X-5	+7.5 to +32.0V
DMS-30/40LCD-X-5B	+7.5 to +12.6V

Operating and Storage Temperature
See applicable meter's data sheet

Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

J1 Connector Information

Terminal Type	DATEL P/N 39-2099090
Crimp Tool	DATEL P/N 39-2099000
Wire Size	22 to 26 AWG

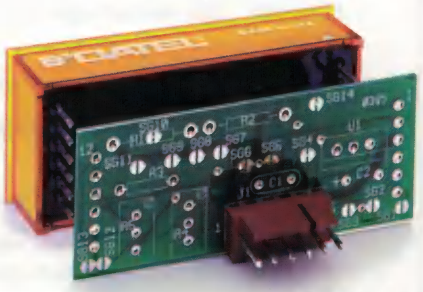
Insulation Diameter
0.062" (1.57mm) maximum

Stripping Length
0.100" to 0.125" (2.54 to 3.17mm)

Ordering Information

DMS-EB	Application board with mating connector and terminals
DMS-BZL1	DMS-30/40 bezel assembly
DMS-BZL2	DMS-30/40 bezel assembly with sealing gasket
RN-DMS	Resistor accessory kit for DMS-30 meters
39-0304000	LM7805CT (U1), +5V-output, three-terminal regulator

The DMS-EB Application Board covers many common panel meter applications while providing simple signal and power I/O terminations (via a standard MOLEX connector) for DATEL's DMS-30 and DMS-40 Series, LED/LCD Display, Digital Panel Voltmeters. The unique plug-and-play design of the DMS-EB makes changing from application to application and meter to meter quick, easy and inexpensive.



Actual Size

The highly versatile DMS-EB has provisions for such common applications as attenuation of high input voltages, gain (span) and offset (zero) adjustments, 9/12V battery operation, and direct decimal point placement. The DMS-EB is compatible with all four versions of the DMS-30 and DMS-40 Series (±200mV, ±2V, ±20V and ±200V) making it interchangeable from meter to meter and application to application. Solder gaps conveniently placed on the board are easily bridged or cut configuring the board to meet each application's specific requirements.

This low-cost addition to DATEL's expanding line of miniature meters is evidence of our continuing commitment to offer the most versatile, easy-to-use, panel meter products.

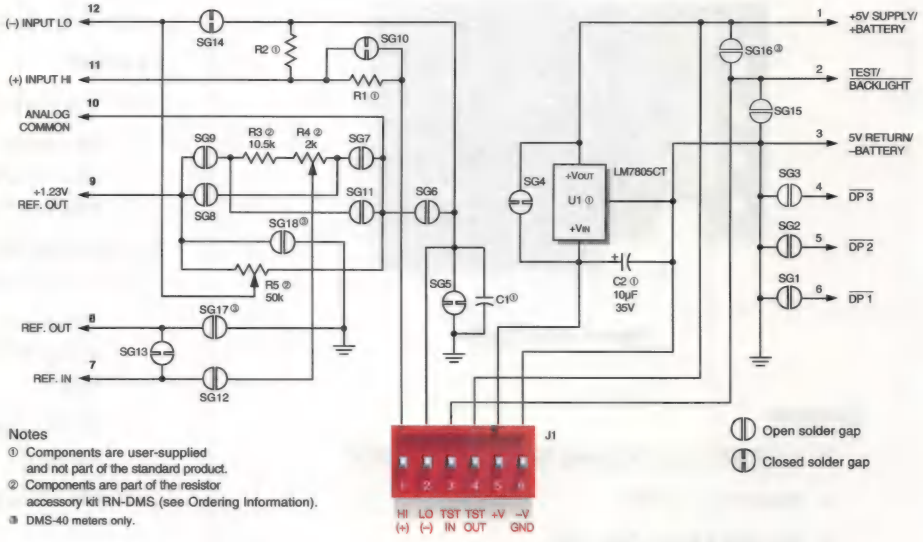


Figure 1. DMS-EB Schematic Diagram for DMS-30 Meters

DS-0279 Rev. A

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Introduction

As shipped, the DMS-EB is configured for 5V-powered DMS-30 3½ digit meters operating in the single-ended mode (SG5 closed) using the meter's internal reference (SG13 closed). This configuration is the most common and works well for most simple voltage measurements.

Many of the applications described below apply to both DMS-30 and DMS-40 meters. However, Application 5, installing the span (R4) and offset (R5) adjust potentiometers, can only be used with DMS-30 meters. Also note that some of the other applications require the installation of R4 and R5. **See Technical Note 5 when using the DMS-EB with DMS-40 meters.**

Please read all of the following technical notes and perform any required modifications **before** soldering the DMS-EB onto the meter (aligning pin 1 to pin 1). After soldering, carefully connect +5Vdc to +V (J1, pin 5) and power return to –V (J1, pin 6).

Technical Notes

1. **LCD Backlighting**: For DMS-30LCD backlit models, close SG15. For DMS-40LCD backlit models close SG18. See the DMS-30LCD or the DMS-40LCD data sheets for limitations on backlighting 9V-powered meters.
2. **9V-Powered, LCD Display Models**: DMS-30LCD-X-9 and DMS-40LCD-X/X-9 meters **cannot** be used in single-ended input configurations, i.e., LO (J1, pin 2) cannot be connected to GND (J1, pin 6). When operating from a 7.5 to 14Vdc power source with a single-ended input, use a +5V-powered meter and install U1 (see Battery Operation section and Technical Note 4).

   Close SG6 when measuring floating inputs with a 9V-powered meter (floating inputs are described in Technical Note 7). SG6 provides a bias reference for the input signal by tying LO to the meter's Analog Common terminal (pin 10).
3. **Input Resistor Dividers**: Use 1%, or better, metal film resistors for R1 and R2 in DMS-30 applications, and 0.5%, or better, in DMS-40 applications. Using tight-tolerance resistors in input divider networks allows most final calibration adjustments to be made with the meter's rear calibration pots through the access holes provided. Make sure the resistor power and voltage ratings are adequate for the given application.
4. **Using U1 (LM7805CT):** The power supply voltage range listed in the Battery Operation section is rated for a 150mA LED meter or a 35mA backlit LCD meter. A 10µF/35V tantalum capacitor (C2) should be installed with the polarized end next to the + symbol on the DMS-EB. This is especially important if the power supply is located far from U1.
5. **DMS-40 Meters**: When the DMS-EB is used with DMS-40PC or DMS-40LCD meters, be sure to open SG13. The RN-DMS resistor accessory kit comprised of resistor R3 and potentiometers R4 (Gain/Span) and R5 (Offset/Zero), **cannot** be used with DMS-40 series meters. To change the input range on DMS-40LCD meters from the low range to the high range, close SG16.
6. **Calibration Potentiometer Adjustment Holes**: Two overlapping holes on the DMS-EB provide access to the ¾-turn calibration potentiometer on DMS-30 meters and the 3-turn potentiometer on DMS-40 meters. The adjustment range of both pots is very narrow. See the applicable product data sheet for more information on each meter's calibration potentiometers.
7. **Input Configurations**: The DMS-EB is supplied with SG5 closed. SG5 connects J1, pin 2 (LO) to power return J1, pin 6 (GND) and configures the meter for single-ended operation, that is, the low side of the input is at system ground or zero Volts. SG5 must also be closed when measuring floating inputs. Floating inputs are signals which have no electrical connection, or reference to, the power supply which powers the meter.

   In applications in which input LO is connected to ground elsewhere in the system, and SG5 is closed, unwanted ground-loop induced display errors may develop. Ground loops, a condition in which display drive currents also flow through the input signal wiring, can cause unstable display readings. If this occurs, try opening SG5 to see if the display stabilizes.

   SG5 must be open when measuring differential inputs that are referenced to the same supply which powers the meter. DMS Application Note 2 (Input Configurations, Power Supplies and Ground Loops) provides a detailed discussion of input configurations.
8. **Soldering:** DATEL recommends the use of "no-clean" solders when installing or making modifications to the DMS-EB.

Applications

1. **Decimal Point Placement:** DATEL ships the DMS-EB with all decimal point solder gaps (SG1, SG2, SG3 and SG17) open. To enable a specific decimal point, close its respective solder gap with solder. When reassigning decimal places for subsequent applications, remember to open previously closed solder gaps.

   Close SG1 for 1.999 (DP1)
   Close SG2 for 19.99 (DP2)
   Close SG3 for 199.9 (DP3)
   Close SG17 for 1999.9 (DP4 on DMS-40)
2. **Display Test:** Tie J1, pin 4 (TEST OUT) to pin 3 (TEST IN) to test the display of the DMS-30. Do not leave the meter in the test mode for more than 10 seconds. Display test is not available on backlit models
3. **Battery Operation:** Do not use this feature with blue LED meters. Open SG4 and install U1 (LM7805CT) with its metal tab facing down as shown Figure 2. Allowable input power ranges (J1, pins 5 and 6) are as follows:

DMS-30/40PC-X-XS	+7.5 to +12.6V
DMS-30/40PC-X-XL	+7.5 to +18.0V
DMS-30/40LCD-X-5	+7.5 to +32.0V
DMS-30/40LCD-X-5B	+7.5 to +12.6V

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Applications

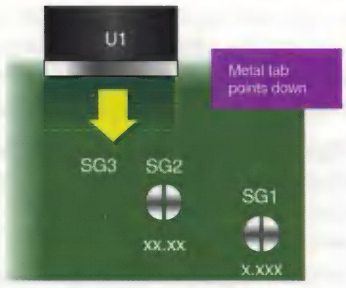

Figure 2. Installing U1

4. **Differential Input Signals** (Signal Referenced to Power Source): Open SG5. Apply the input signal to pin 1, (+) IN HI, and pin 2, (–) IN LO, of J1.

   Note: Common mode voltage must not exceed ±2Vdc. Differential signals are defined as inputs whose two terminals are both above and below J1, pin 6 (GROUND).

5. **Span (Gain) and Zero (Offset) Adjustments:** DATEL offers a resistor accessory kit consisting of resistor R3 and potentiometers R4 and R5. Once installed, these components permit the span and zero adjustments described in the following sections. R3 and R4 provide span adjust while R5 applies an offset to (–) IN LO (J1, pin 2).

Using Full Range Span Adjustment (DMS-30 Only)

1. For DMS-30-1 and -2 models: Configuring the DMS-EB for span adjustment is simply a matter of installing resistor R3 and potentiometer R4, opening SG13 and then closing SG8, SG11 and SG12.
2. For DMS-30-0 models: Span adjustment requires that you open SG8, SG11 (if closed) and SG13 and then close SG7, SG9 and SG12. Then install R3 and R4.

Adjust span as desired. DMS-30-1 and -2 span adjustment range is typically +10% and –5%. The DMS-30-0 has a much wider span adjust, however, it should be limited to ±10% for optimum accuracy.

6. **Measuring Input Voltages Greater than 1.999Vdc** (Use DMS-30-1 Only): If possible, the resistors used for R1 and R2 should be ±1% metal-film types with TCR's less than 100ppm/°C. More information on selecting 1% resistors can be found in Application Note 14 of the DATEL Panel Meter Catalog.

   CAUTION: Do not exceed 250Vdc input signals.

   1. Open SG10. For applications in which input voltages exceed ±100Vdc, also cut the 2 adjoining traces.
   2. Configure the DMS-EB for span adjust using the procedure previously outlined for the DMS-30-1 version.
   3. Calculate values for R1 and R2 as follows:

      A typical value for R1 is 1MΩ. The sum of R1 + R2 should be between 50kΩ and 10MΩ.

      $R2 = (FSI \times R1) / (|V_{IN}| - FSI)$

      Where:

      FSI = The attenuated voltage, between the meter's (–) IN LO and (+) IN HI pins, needed to achieve the desired display readings

      V_{IN} = Input voltage at J1 (between pins 1 and 2)

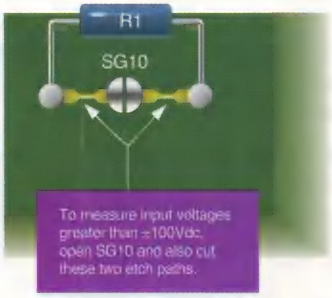

Figure 3. Installing R1

Example

V_{IN} is 0-5Vdc, and the display reading must be "000" to "1500".

1. Assume R1 = 1.0MΩ.
2. $R2 = (FSI \times R1) / (|V_{IN}| - FSI)$
   $R2 = (1.500 \times 1{,}000{,}000) / (5.0 - 1.500)$
   $R2 = 428{,}571\Omega$ or $432k\Omega$
3. Calibrate the meter using a known voltage source. Adjust R4 to compensate for variations in R1 and R2.

7. **Current Measurements** (Use 200mV Model, DMS-30-0): The following instructions are for measuring current derived from the DMS-30/40's power source. When measuring current that is floating with respect to J1, pin 6 (POWER RETURN), leave SG5 closed.

   CAUTION: Do not exceed 1 Ampere input current

   1. Install R2: $R2 = FSR / (I_{MAX.} \times 10000)$ where FSR is the desired meter reading (0-1999) and I_{MAX} is between 0-1 Ampere.
   2. Open SG5.
   3. Configure the DMS-EB for span adjust using the procedure previously outlined for the DMS-30-0 version.
   4. Apply input signal (current) to (+) IN HI and (–) IN LO.
   5. Adjust R4 for desired full scale readings.
   6. Enable the appropriate decimal point using either SG1, SG2, SG3 or SG-18.

Example

A 0.100 Ampere input must read "100.0" on the display.

$R2 = 1000 / (0.1 \times 10000)$
$R2 = 1$ Ohm
Enable DP3 via SG3 for a reading of "100.0".

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DMS-EB-AC/DC

AC Primary Power Application Board for DMS-30PC/LCD Meters

Features

- **Allows meters to operate from 105 to 240Vac (60Hz) line voltage**
- **Screw-type terminal block connections**
- **Provides 750V (min.) input-to-output isolation**
- **Has most features of the standard DMS-EB board**
- **Low cost**

Functional Specifications

(TA = +25° C)

Power Inputs:
105 to 240Vac, 60Hz
180 to 240Vac, 50Hz

AC Input Frequency
48 to 68Hz

Input Current (AC) @ 120Vac, 60Hz
25mA (±5mA)

Isolation
750V, minimum

Operating Temperature Range
0 to +60°C

Storage Temperature Range
–20 to +75°C

Humidity
0 to 95%, non-condensing

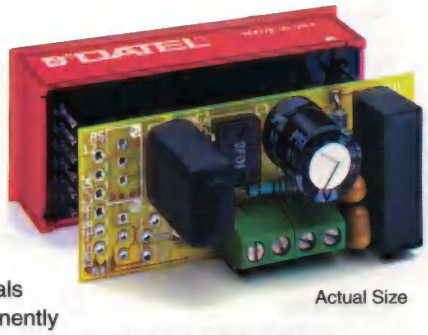
Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

TB1 Wire Size and Strip Length:
18-26 AWG (solid or stranded)
Strip length 0.20" (5.08mm)

Ordering Information

DMS-EB-AC/DC	AC/DC application board
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket
RN-DMS	Resistor accessory kit

Technical Notes



Actual Size

Description: This low-cost add-on board provides a quick and easy way of powering either DMS-30PC (red low-power models only) or DMS-30LCD (non-backlit models only) meters from 105-240Vac (60Hz) line power. The on-board AC/DC converter provides +4.3Vdc to power the meter while providing 750V isolation between the ac line and the input signal. Line power and input signals connect to a screw terminal block (TB1) permanently mounted on the DMS-EB-AC/DC. This type of terminal block provides reliable mechanical connections and eliminates any extra wiring harness connectors.

Modification: For application information, refer to the DMS-EB data sheet (battery operation section does not apply). Please note that unlike all other DMS-EB boards, the DMS-EB-AC/DC does not have all of its solder gaps located on the component side. Solder gaps SG5 thru SG9 and SG11 thru SG14 are located on the back side of the board. This is the side with no components. Be sure to read the modification instructions in the DMS-EB data sheet carefully before soldering the DMS-EB-AC/DC to its host meter.

Safety: In many applications, DMS-EB-AC/DC installation is subject to electrical-code requirements (for example, the NEC in the USA). Fusing, grounding, wire gauges and leakage currents may be regulated items. Since the DMS-EB-AC/DC is a line-operated device, it presents a shock hazard and should be installed only by qualified personnel. Do not hesitate to contact DATEL if you have any questions.

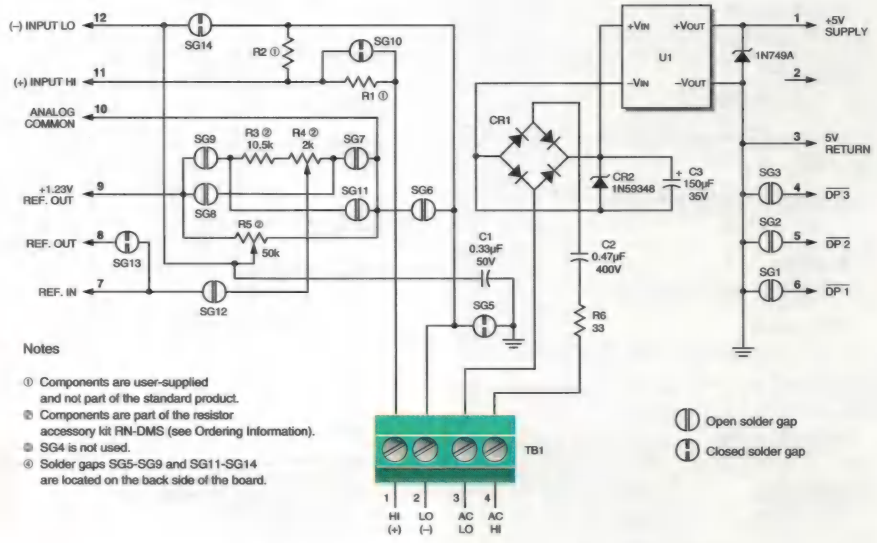


Figure 1. DMS-EB-AC/DC Schematic Diagram

DS-0341 Rev. A

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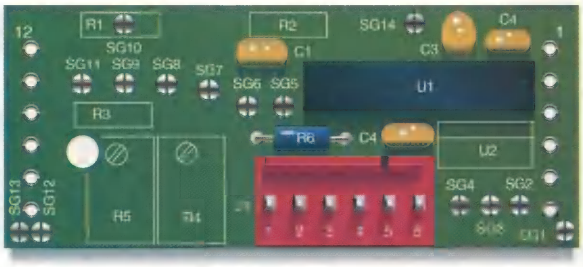


DMS-EB-DC/DC

DC/DC Converter and Isolation Board for DMS-30PC/LCD Meters

Features

- **Provides isolated +5V power for DMS-30 Series meters**
- **750V minimum isolation**
- **Ideal for high-side dc ammeter shunts**
- **Provisions for +12V operation**
- **Includes all the features of the standard DMS-EB board**
- **Use with:**
  All DMS-30PC (except blue)
  DMS-30LCD (5V models only)

Functional Specifications

(TA = +25°C, VCC = +5V)

Input Voltage
+5V (±5%)

Input Current:

Typical	+150mA
Maximum	+250mA

Regulator Input Voltage Range (LM7805CT):

DMS-30PC-X-XS	+7.5 to +9.5Vdc
DMS-30PC-X-RL	+7.5 to +18Vdc
DMS-30LCD-X-5(B)	+7.5 to +18Vdc

Output Voltage
+5V (±10%)

Isolation
750V, minimum

Operating Temperature Range
0 to +60°C

Storage Temperature Range
–20 to +75°C

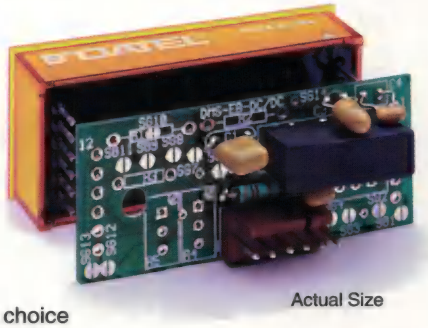
Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

Ordering Information

DMS-EB-DC/DC	DC/DC converter board (with mating connector)
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket
RN-DMS	Resistor accessory kit

Technical Notes



Actual Size

Description: The DMS-EB-DC/DC Application Board provides isolated +5V power for DATEL's DMS-30PC/LCD Series, 3½ Digit, LED/LCD Display, Digital Panel Voltmeters. This add-on board is ideal for applications requiring isolation (up to 750V) between the input signal and the meter's +5V supply.

Features: The DMS-EB-DC/DC is an excellent choice for dc ammeter applications. These ammeters typically have the current shunt located on the positive side of the power supply — a condition which usually exceeds the meter's common mode voltage limit. Input-to-output isolation is required if the power source being measured also powers the DMS-30. DATEL's new Panel Meter Catalog has a detailed application note on dc ammeters.

Applications: The DMS-EB-DC/DC incorporates all standard features of the DMS-EB board; the only exception being the smaller allowable range of power supply voltage when using the LM7805 3-terminal regulator. Use the DMS-EB-DC/DC with any DMS-30PC meter (except blue LED models) or DMS-30LCD meter (5V-powered models only).

+7.5-18V Operation (Optional): Open SG4 and install U2 (LM7805CT) with its metal tab adjacent to U1. Applications requiring a lower dropout voltage should consider the LM2931T-5. Exceeding the allowable regulator input voltage ranges (see Functional Specifications) will cause device overheating! As is the case when specifying any electronic power component, be sure to consult all applicable manufacturer's data sheets.

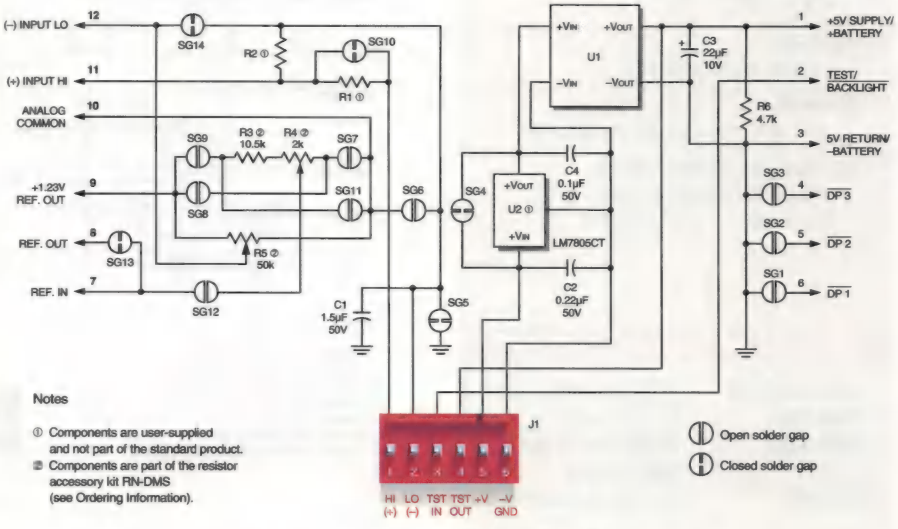


Figure 1. DMS-EB-DC/DC Schematic Diagram

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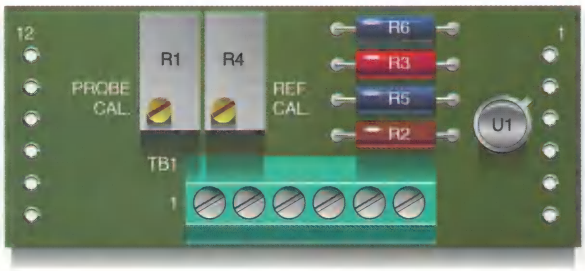


DMS-EB-HTB

High-Accuracy Temperature Sensor Boards for DMS-30PC/LCD Meters

Features

- **Accepts inputs from user-supplied solid-state temperature sensors**
- **Available in °C or °F output readings**
- **6-wire screw-type terminal block**
- **Measures temperatures from –55 to +150°C (–67 to +199.9°F)**

Functional Specifications

(TA = +25°C, Vcc = +5V)

Measurement Range:
DMS-EB-HTBC –55 to +150°C
DMS-EB-HTBF –67 to +199.9°F

Sensor Type
AD590 active linear device

Accuracy:
Typical ±0.3°C (or °F)
Maximum ±1.0°C (or °F)

Operating Voltage Range
+5V (±10%)

Input Current (Board only):
Typical +0.8mA
Maximum +1.0mA

Sensor Lead Length
3 feet, maximum

Operating Temperature Range
0 to +60°C

Storage Temperature Range
–20 to +75°C

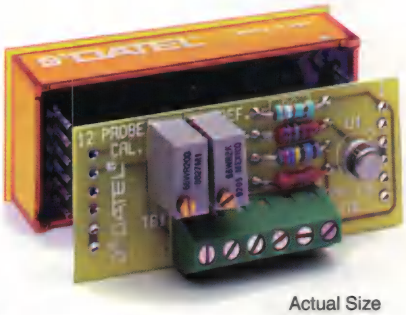
Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83"(21.08mm)W

Ordering Information

DMS-EB-HTBC	High-accuracy temperature probe board, Celsius
DMS-EB-HTBF	High-accuracy temperature probe board, Fahrenheit
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket

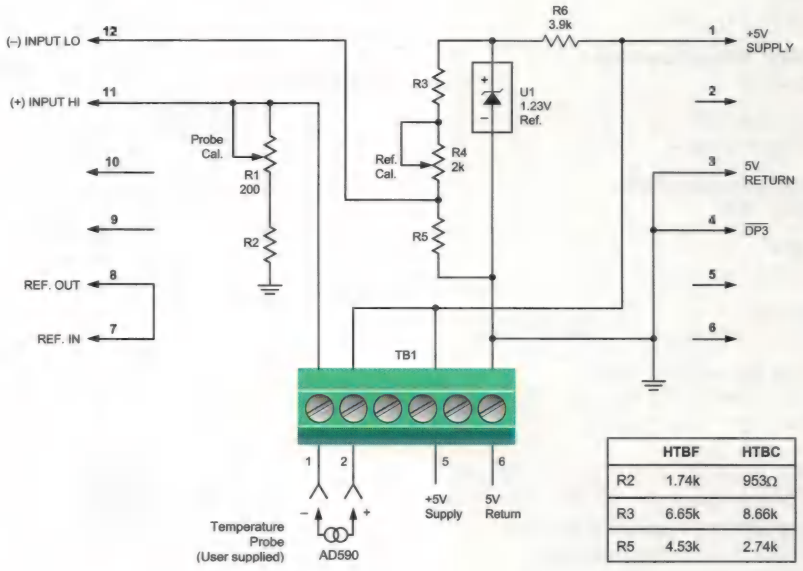
Technical Notes



Actual Size

Description: The DMS-EB-HTB Application Boards accept inputs from user-supplied, AD590 solid-state temperature sensors. The boards can be used with any of DATEL's ±200mV, 5V-powered DMS-30PC/LCD Series, 3½ Digit, LED/LCD Display, Digital Panel Voltmeters — although better performance can be achieved with either LCD or low-power LED models. This meter/board combination provides extremely accurate (±0.3°C) temperature measurements over the range of –55 to +150°C(with DMS-EB-HTBC) or –67 to +199.9°F (DMS-EB-HTBF). Individual reference-adjust and probe-adjust potentiometers allow for "fine tuning" the AD590 output to precisely match the selected meter. A 6-wire, screw-type terminal block provides for quick, reliable, signal and power connections.

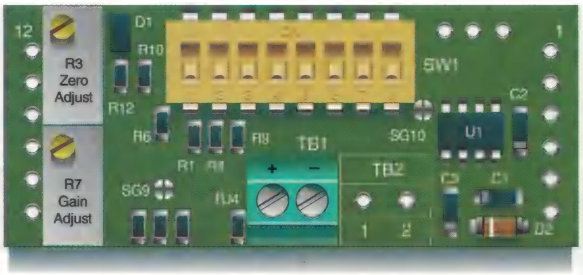
Calibration: R4 (Reference Adjust) is factory-calibrated to +459.8mV for °F and +273.2mV for °C (do not readjust). This measurement is taken between TB1 (pin 6) and pin 12 of the DMS-30PC/LCD. R1 (Probe Adjust) requires customer adjustment since every sensor has a slightly different zero offset. Calibration is simple: connect the sensor leads to TB1 and adjust R1 until the DMS-30's display matches a selected reference temperature indicator.



	HTBF	HTBC
R2	1.74k	953Ω
R3	6.65k	8.66k
R5	4.53k	2.74k

Figure 1. DMS-EB-HTB Schematic Diagram

5



DMS-EB-LP

4-20mA Current Loop Application Board for DMS-30LCD Meters

Features

- **Loop-powered, no external supply required**
- **Includes gain (span) and offset (zero) adjustments**
- **Range and decimal point settings are DIP-switch selectable**
- **Covers hundreds of different ranges**
- **Reliable screw-terminal connections**
- **Low cost**

Functional Specifications

(TA = +25°C)

Full Scale Input
4mA to 20mA

Voltage Drop
7.5V, maximum

Input Resistance
550Ω, nominal

Accuracy
±0.05%FS ±1 count

Operating Temperature Range
0 to +60°C

Temperature Drift
±100ppm/°C, typical

Storage Temperature Range
–20 to +75°C

Humidity
0 to 95%, non-condensing

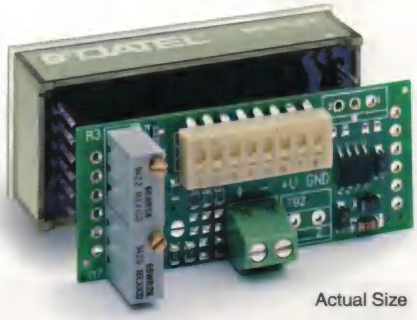
Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

TB1 Wire Size and Strip Length:
18 to 26 AWG (solid or stranded)
Strip Length 0.20" (5.08mm)

Ordering Information

DMS-EB-LP	Current loop board
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket

Technical Notes



Actual Size

Description: The DMS-EB-LP was specifically designed for 4-to-20mA current-loop process-monitoring applications. The board simply mounts onto the rear of a DMS-30LCD-1-5, allowing both the application board and the meter to be powered solely from the 4-to-20mA loop input. Align pin 1 of the board with pin 1 of the DMS-30LCD-1-5 and simply solder the two assemblies together.

Features: Gain (span) and offset (zero) adjustments are both performed using precision, 22-turn potentiometers. Decimal point selections and range changes are all made on an eight-position DIP switch featuring gold-plated contacts — there are no cumbersome jumpers or solder gaps to contend with! Connections to the loop are made via a reliable, screw-type terminal block. The only assembly tool required is a screwdriver!

Applications: The DMS-EB-LP's design accommodates hundreds of different display reading combinations. This essentially eliminates the need to order "specials" in applications in which several different-range meters are required. OEM customers should consider using DATEL's new DMS-30LCD-4/20S which already has the DMS-EB-LP soldered to a rugged DMS-30LCD-1-5 digital voltmeter.

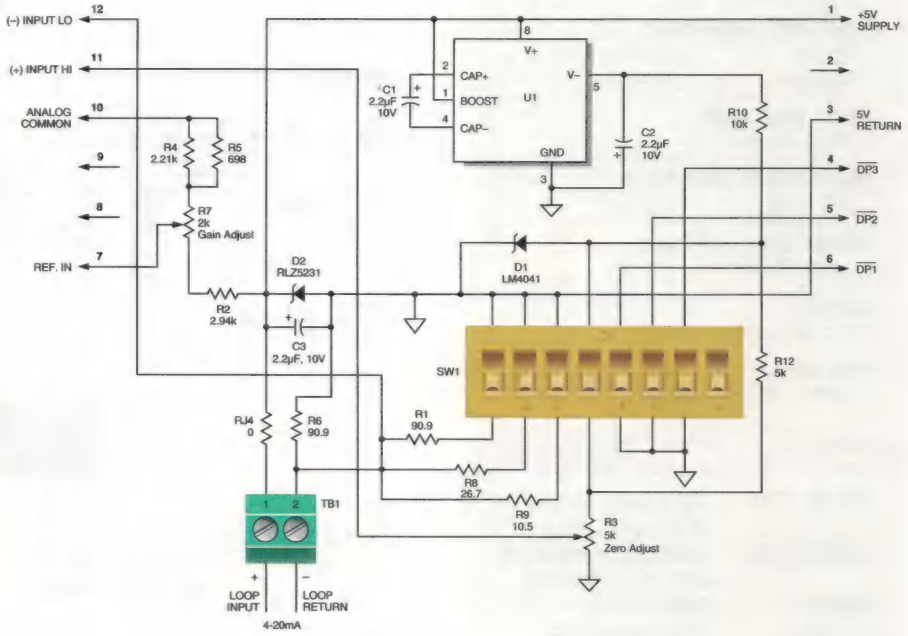


Figure 1. DMS-EB-LP Schematic Diagram

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Operating and Setup Instructions

As shipped, the DMS-EB-LP is factory calibrated to read "000" for a 4mA input and "1999" for a 20mA input but may require recalibration when connected to a DMS-30LCD-1-5 digital voltmeter.

The following worst-case procedure assumes the DMS-EB-LP is completely mis-adjusted, i.e., both potentiometers and the DIP switches are randomly set.

1. Set R7 (full scale gain adjust) and R3 (zero/offset adjust) fully clockwise, roughly 22 turns, and place SW1-SW8 to OFF (down position).
2. Set SW1 to ON (up position). See DIP switch setting #3 in Table 1.
3. Apply a precision 4mA input, with proper polarity, and adjust R3 until the meter's display reads "000".
4. Apply a precision 20mA input and adjust R7 until the meter's display reads "1999". Repeat steps 3 and 4 to make sure the adjustments do not affect one another.
5. Select the appropriate decimal point by setting SW5, SW6 or SW7 to ON (DP1, DP2 or DP3 respectively).

   NOTE: If a display reading other than "000" to "1999" is desired, refer to Table 1 for SW1-SW4 settings.

Display Reading	SW1	SW2	SW3	SW4
1. 000 to 100-300	On	On	On	Off
2. 000 to 400-600	Off	On	Off	Off
3. 000 to 700-1999	On	Off	Off	Off
4. ±100	On	On	On	Off
5. ±200 to ±300	On	On	Off	Off
6. ±400 to ±600	On	Off	Off	Off
7. ±700 to ±1900	Off	Off	Off	On

Table 1. DIP-Switch Settings

NOTE: When looking up DIP-switch settings in the Table and the desired display readings happen to fall between two switch settings, try performing the adjustments with both settings to determine which one offers the better settability. Please keep in mind that the DMS-30LCD meter has an accuracy specification of ±2 counts (max.). Thus, it may not always be possible to obtain the exact desired display reading.

Examples

1. Desired display readings are:

   4mA ="0.00"
   20mA = "2.00"

   Use DIP-switch setting #1 and enable decimal point DP2 via SW6. Apply 4mA and adjust R3 so the display reads "0.00". Apply 20mA and adjust R7 so the display reads "2.00".

2. Desired display readings are:

   4mA =" –100"
   12mA = "000"
   20mA = "100"

   Use DIP-switch setting #4. Apply 12mA and adjust R3 so the display reads "000". Apply 20mA and adjust R7 so the display reads "100". Apply 4mA and the display should read "–100". For these display readings, no decimal points are used. Set SW5, SW6 and SW7 to OFF (down position).

3. Desired display readings are:

   4mA = "-157.5"
   12mA = "00.0"
   20mA = "157.5"

   Use DIP-switch setting #7 and enable decimal point DP3 via SW7. Apply 12mA and adjust R3 so the display reads "000". Apply 20mA and adjust R7 so the display reads "157.5". Apply 4mA and the display should read "–157.5".

4. Desired display readings are:

   4mA = ".000"
   12mA = ".250"

   This example is not as straightforward as the previous three. Notice that 12mA is exactly halfway between 4mA and 20mA. If we assume that the input *could* go up to 20mA, the display reading would then be: 2 x .250 or ".500". From the chart, we can now select DIP-switch setting #2 and enable DP1 via SW5. Apply 4mA and adjust R3 so the display reads ".000". Apply 12mA and adjust R7 so the display reads ".250".

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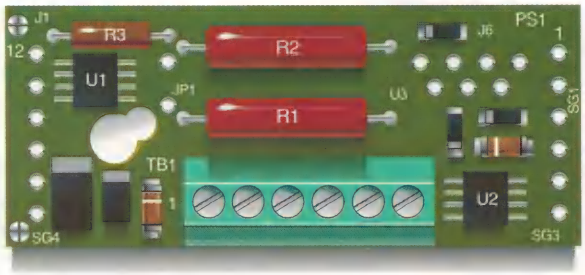


DMS-EB-RMS

AC-to-RMS Converter Application Board for DMS-30PC/LCD Meters

Features

- Displays true rms values of ac inputs
- ±0.5% accuracy for DMS-30PC-0 or DMS-30LCD-0-5
- ±2% accuracy for DMS-30PC-1 or DMS-30LCD-1-5
- Also works with DMS-40PC/LCD meters (see Ap Note 11)

Functional Specifications

(TA = +25°C, Vcc = +5V)

Vac Measurement Range:
±200mV meters 0 to 199.9Vac
±2V meters 0 to 750Vac

Conversion Accuracy:
0-200Vac ±0.5%
0-750Vac ±2%

Crest Factors
3, maximum

Input Frequency Range
40Hz to 2kHz

Primary Operating Power
+5V (±5%)

Current Consumption (Board only)
+0.5mA typ., +1mA max.

Operating Temperature Range
0 to +60°C

Storage Temperature Range
–20 to +75°C

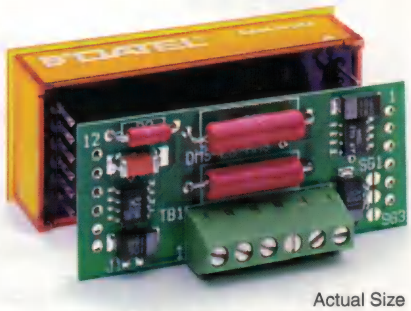
Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

Ordering Information

DMS-EB-RMS	AC-to-RMS conversion board
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket

Technical Notes



Actual Size

Description: The DMS-EB-RMS board allows the true rms value of ac signals to be displayed on 5V-powered DMS-30PC/LCD digital voltmeters. The meter/board combination has an input range of 0-750Vac with ±2V meters (1Vac resolution) or 0-199.9Vac with ±200mV meters (0.1Vac resolution). A built-in screw-terminal block reliably interfaces signal and power connections. The DMS-EB-RMS now accommodates user-installed modifications such as input-scaling resistors and isolated +5V dc/dc converters.

Power and Safety Precautions: The DMS-EB-RMS's AC HI and AC LOW inputs are not electrically isolated from its 5V supply (AC LOW is connected directly to 5V RETURN). When measuring any input signal which is derived from ac power mains, a dedicated (i.e., it only powers the DMS-EB-RMS), transformer-isolated +5V supply, with a minimum 1kV breakdown rating, **must be used** to power the DMS-EB-RMS board/meter combination. When measuring ac power mains inputs, never connect the DMS-EB-RMS's 5V RETURN to chassis/earth ground anywhere in the system. Failing to follow these instructions could defeat any safety grounding and will place the system +5V power supply, and all its associated circuitry, at dangerously elevated ac-line potentials. In many applications, the DMS-EB-RMS installation is required to meet electrical code requirements. **To ensure safe operation, the DMS-EB-RMS board should only be installed and serviced by technically-qualified personnel**. See DMS Application Note 11 for more details.

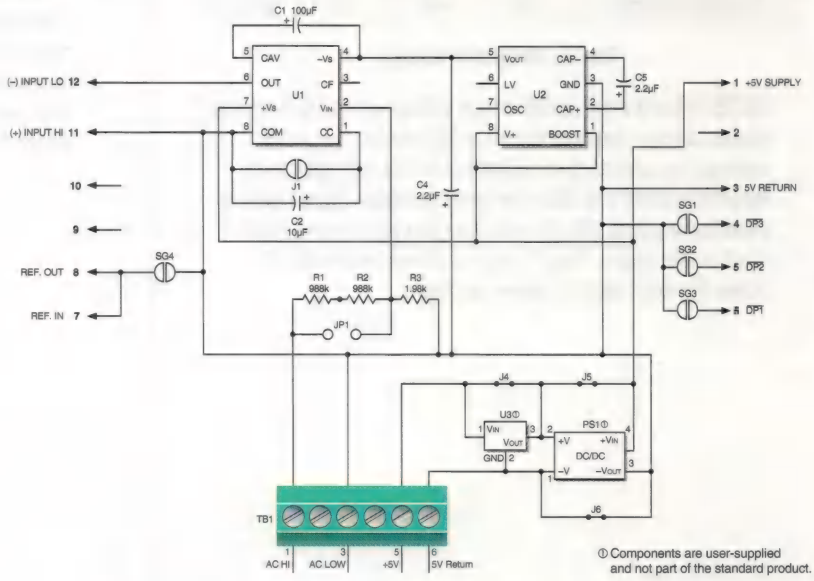


Figure 1. DMS-EB-RMS Schematic Diagram

DS-0398 Rev. A

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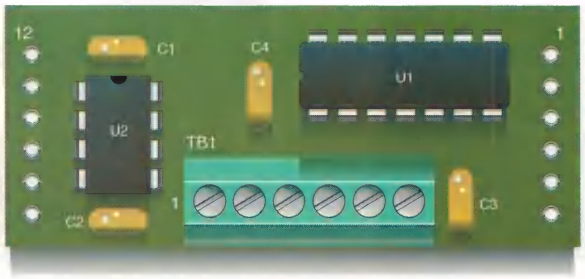


DMS-EB-TCJ/TCK

Thermocouple Input Application Boards for DMS-30PC/LCD Meters

Features

- Displays –50 to +200°C range
- Interfaces with type J or K type thermocouples
- Typical accuracies as low as ±1.5°C
- Use with:
  DMS-30PC-1-RL
  DMS-30LCD-1-5

Functional Specifications

(TA = +25°C, Vcc = +5V)

Sensors
Type J and K thermocouples

Temperature Measurement Range
–50 to +200°C

Accuracy:

DMS-EB-TCJ	
–50 to 0°C	±6°C typ., ±10°C max.
0 to +200°C	±4°C typ., ±8°C max.
DMS-EB-TCK	
–50 to 0°C	±6°C typ., ±10°C max.
0 to +200°C	±1.5°C typ., ±3°C max.

Primary Operating Power
+5V (±5%)

Input Current (Board only)
+0.6mA typ., +1mA max.

Operating Temperature Range
0 to +60°C

Storage Temperature Range
–20 to +75°C

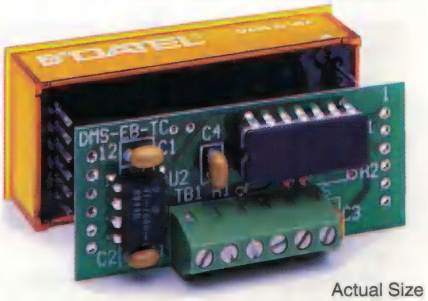
Humidity
0 to 95%, non-condensing

Dimensions
2.02" (51.31mm)L x 0.83" (21.08mm)W

Ordering Information

DMS-EB-TCJ	Type J thermocouple input board
DMS-EB-TCK	Type K thermocouple input board
DMS-BZL1	Bezel assembly
DMS-BZL2	Bezel assembly with sealing gasket

Technical Notes



Actual Size

Description: The DMS-EB-TCJ and DMS-EB-TCK Application Boards interface type J or K thermocouples to DATEL's low-power, ±2V input, DMS-30PC-1-RL or DMS-30LCD-1-5 digital voltmeters. These low-cost add-on boards provide a quick easy method of displaying temperature (in degrees Celsius only) within a –50 to +200°C range.

Installation: A screw-type terminal block (TB1) accepts direct thermocouple inputs and provides quick connection for the +5V power supply. All necessary I/O connections for the meter — including activation of the correct decimal point — are built-in. Simply solder the board to the meter, connect the appropriate thermocouple, and the installation is complete. Using low-power meters, with either LCD or LED displays, will maintain uniform temperatures across the board and keep temperature-gradient induced errors to a minimum.

Accuracy: As the accuracy specifications indicate, the DMS-EB-TCJ and TCK boards are for general-purpose temperature monitoring over the range of –50 to +200°C. However, fairly high accuracy can be obtained with K thermocouples from 0 to +200°C. For higher accuracy temperature readings, see the DMS-EB-HTB.

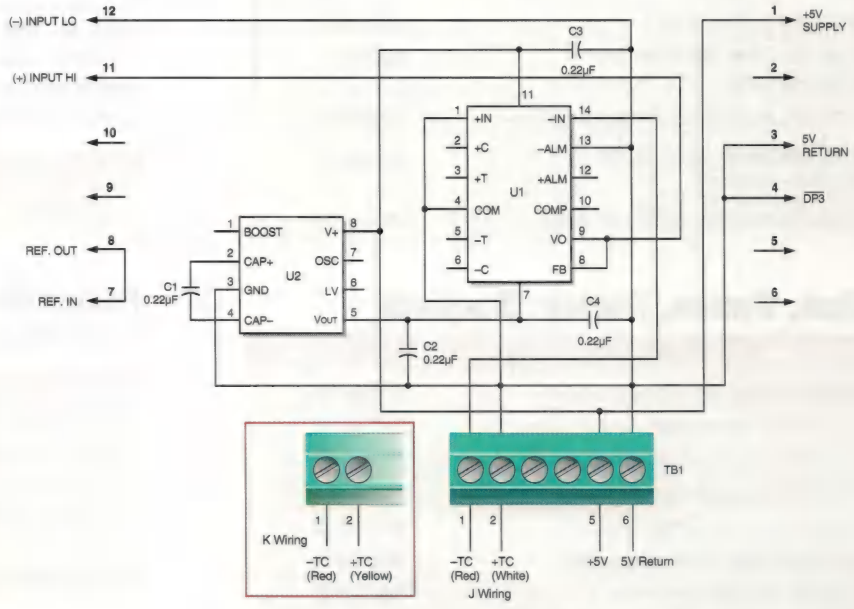
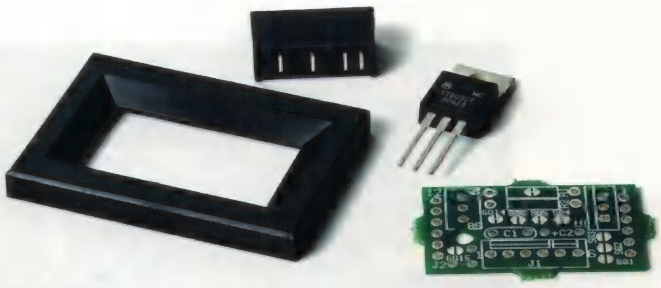


Figure 1. DMS-EB-TCJ/TCK Schematic Diagram

DMS Accessories



Accessories for DMS-EB Boards

Description	DATEL Part Number
Resistor kit for DMS-EB, EB-AC/DC and EB-DC/DC application boards. Includes 2, precision, 20-turn potentiometers.	**RN-DMS**
Unpopulated (no components/connectors) DMS-EB application board for DMS-30 meters. Minimum order is one 5 x 2 panel (10 boards).	**39-2068200**
Unpopulated (no components/connectors) DMS-EB2 application board for DMS-20 meters. Minimum order is one 5 x 3 panel (15 boards).	**39-2068235**

Bezels and Panel Cutout Punches

See product data sheets for bezel mechanical dimensions.

Description	DATEL Part Number
Bezel for all DMS-30 and DMS-40 Meters	**DMS-BZL1**
Bezel with EPDM sealing gasket for all DMS-30 and DMS-40 Meters	**DMS-BZL2**
DMS-30/40PC bezel & filter for red LED meters	**39-2359620**
Bezel for all DMS-20 Meters	**DMS-BZL3**
Bezel with EPDM sealing gasket for all DMS-20 Meters	**DMS-BZL4**
DMS-20PC bezel & filter for red LED meters	**39-2359621**
Panel cutout punch for all DMS-30 and DMS-40 Meters	**DMS-30-CP**
Panel cutout punch for all DMS-20 Meters	**DMS-20-CP**

Clips, Cases, Plates, Sockets

Description	DATEL Part Number
DMS-20 retaining clip, minimum order: 10	**39-2165105**
DMS-20PC red plastic case, minimum order: 10	**39-2359550**
DMS-30/40 retaining clip, minimum order: 10	**39-2165110**
DMS-30/40 red plastic case, minimum order: 10	**39-2359513**
DMS-20 panel mount adapter plate	**39-2359623**
DMS-30/40 panel mount adapter plate	**39-2359622**
6-position pc board mount socket	**39-2359625**
12-position pc board mount socket (-BCD models)	**39-2359624**

Power Supplies

AC/DC Converters: Ideal for prototyping applications. Plug directly into wall outlets (USA style only) to provide an isolated +5/12Vdc @ 500/200mA from 120Vac.

Output Power	Nominal Input Voltage	DATEL Part Number
+5V/500mA	120Vac/60Hz	**UPA-5/500**
+12V/200mA	120Vac/60Hz	**UPA-12/200**

DC/DC Converters: Provide isolated +5Vdc outputs @ 150mA from +5/12/24V inputs. 4-pin, plastic, single-in-line (SIP) packages. Minimum order quantity is 2 pieces. See next page.

Output Power	Nominal Input Voltage	DATEL Part Number
+5V/150mA	+5Vdc	**39-0276600**
+5V/150mA	+12Vdc	**39-0276715**
+5V/150mA	+24Vdc	**39-0276610**

Linear Regulators: LM7805CT 3-terminal regulator in standard TO-220 package. Provides a regulated +5Vdc output from a nominal +7.5-28Vdc input. See next page and data sheets for individual panel meters and application boards for additional information on allowable supply ranges. Minimum order quantity is 5 pieces.

Output Power	Nominal Input Voltage	DATEL Part Number
+5V/1000mA	+7.5-28Vdc	**39-0304000**

Panel Mount Connectors

For all DMS Series Meters

Description	DATEL Part Number
6-position connector housing. Use with crimp terminal 39-2099090. Minimum order 20 pieces.	**39-2079400**
Crimp terminal for connector housing 39-2079400. Accepts 22-26 AWG wire. Minimum order 120 pieces.	**39-2099090**
Crimp tool for 39-2099090 terminals.	**39-2099000**

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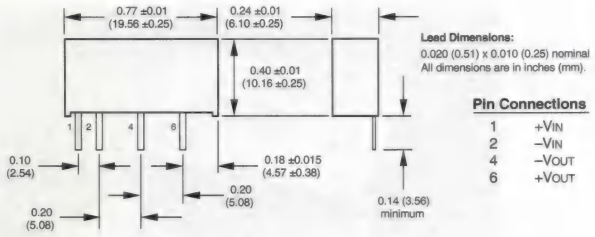
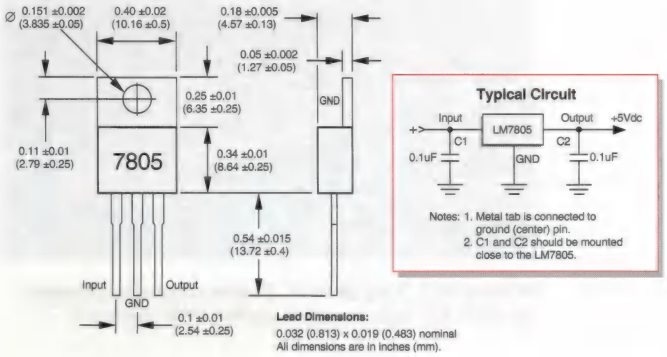
5 Volt, Isolated and Non-Isolated DC/DC Converters for DMS Series Meters

Isolated: These miniature, 5V-output dc/dc converters are ideal for applications requiring isolation between the input signal being measured and the panel meter's +5V power source. They can eliminate common mode voltages up to 750V. A popular application requiring isolation is high-side, current-shunt, dc ammeters (see DMS Ap Note 6 for information on dc ammeters). Any 5V-powered, 3½ digit, DMS Series meter whose supply current does not exceed 225mA may be powered from these converters. Low-noise operation can be obtained in most 4½ digit meter applications by simply adding filter components to the converter's output pins.



Non-Isolated: The LM7805CT (DATEL part number 39-0304000) is a highly reliable, three-terminal IC regulator that provides a non-isolated +5V output from input voltages between +7.5 and +28Vdc. However, when it is used to power DATEL DMS Series panel meters, the allowable operating input voltage applied to the LM7805CT should not exceed the ranges specified in the table below. The LM7805CT can be used with the DMS-EB, DMS-EB2 and DMS-EB-DC/DC application boards; each board is pre-wired to accept the regulator. Refer to each board's data sheet for more information. Please consult DATEL's Application Engineers if you have any questions regarding the use of dc/dc converters with any DMS Series meter.



Electrical Specifications (Isolated)

DATEL Part No./Marking	Nominal Input Voltage	Input Current Min. Load		Input Current Max. Load	
39-0276600/HPR100	+5Vdc	20mA		216mA	
39-0276715/HPR106	+12Vdc	10mA		90mA	
39-0276610/HPR118	+24Vdc	8mA		44mA	
Input Range	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
39-0276600		+4.5	+5	+5.5	Vdc
39-0276715		+10.8	+12	+13.2	Vdc
39-0276610		+21.6	+24	+26.4	Vdc
Output					
Rated Current		—	150	—	mA
Voltage Setpoint	Rated load, nom. V_{IN}	+4.75	+5.0	+5.5	Vdc
Ripple and Noise	BW=dc to 10MHz BW=10Hz to 2MHz	— —	45 30	— —	mVp-p mVrms
Isolation					
Rated Voltage		750	—	—	Vdc
Test Voltage	60Hz, 10 seconds	750	—	—	Vpk
Leakage Current	Viso=240Vac, 60Hz	—	2	8.5	µArms
Temperature					
Operating		–25	—	+85	°C
Storage		–40	—	+110	°C
Absolute Maximum Ratings					
Internal Power Dissipation				450mW	
Output Short-Circuit Duration				1 second	
Lead Temperature (soldering, 10 seconds max.)				+300°C	

Electrical Specifications (Non-Isolated)

Input Range	Min.	Typ.	Max.	Units
Input Voltage	+7.5	—	+28	Vdc
Output @+25°C				
Output Voltage	+4.75	+5.0	+5.5	Vdc
Output Current	—	—	1000	mA
Maximum Input ①				
DMS-20PC-X-XS	+7.5	—	+12.6	Vdc
DMS-20PC-X-XL	+7.5	—	+24.0	Vdc
DMS-30PC-X-XS	+7.5	—	+12.6	Vdc
DMS-30PC-X-XL	+7.5	—	+18.0	Vdc
DMS-30LCD-X-5(B)	+7.5	—	+18.0	Vdc
Temperature				
Operating	–25	—	+85	°C
Storage	–40	—	+110	°C

① When used with the following DMS Series panel meters up to +60°C max.

DS-0352 Rev. A

5

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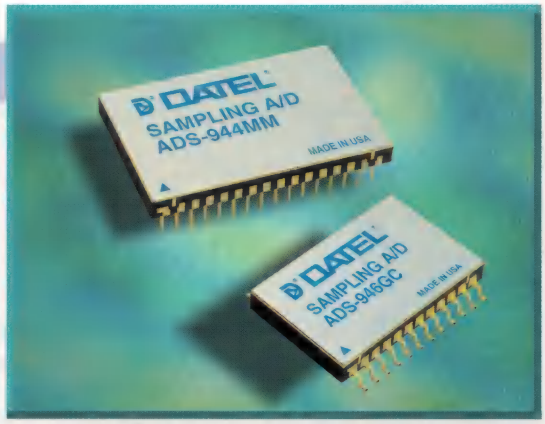

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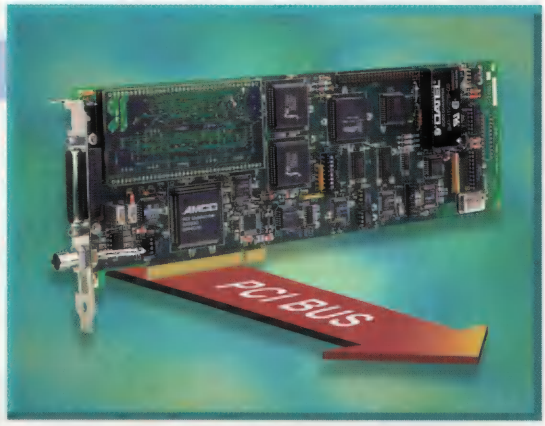

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Application Notes

DATEL has designed and manufactured digital panel meters (DPM's) for more than 20 years. During that time, we've learned a fair amount about the technical challenges encountered when applying something as deceptively "low-tech" as a DPM. The apparently straightforward isn't always so.

All the topics covered in the following ap notes are the result of customer calls for assistance. The content, though sometimes general in nature, is specific to DATEL's DMS Series Digital Panel Voltmeters and may not apply to other meters. Additional applications information appears on individual product data sheets.

The abbreviated format of these ap notes indicates their intention to serve as "starting points" for detailed real-world applications. You will no doubt encounter challenges we can not anticipate, so we have purposely not tried to address all details.

Our skilled Applications Engineers welcome the opportunity to assist you right from the beginning of your next project. Most of our experience, however, is helping people whose deadline was yesterday. Please call us whenever you need us.

Table of Contents

1. The LED versus LCD Decision 6-3
2. Input Configurations, Power Supplies and Ground Loops 6-4
3. ANALOG COMMON and REFERENCE IN-OUT 6-6
4. Engineering Scaling 6-8
5. Ohmmeter Circuits 6-9
6. Direct Current Ammeters 6-10
7. Implementing a Line Frequency Meter 6-12
8. Single-Component Thermometers 6-13
9. 2000 RPM Tachometer 6-14
10. Minimum-Component Battery Monitors 6-15
11. Using the DMS-EB-RMS Board 6-16
12. Signals with Zero Offsets 6-18
13. Decimal Point Drivers 6-20
14. Selecting 1% Resistors 6-21
15. Troubleshooting Guide 6-22
16. Typical Meter Installations 6-23
17. Introduction to 2-Wire Meters 6-24
18. Recommended Component Suppliers 6-25

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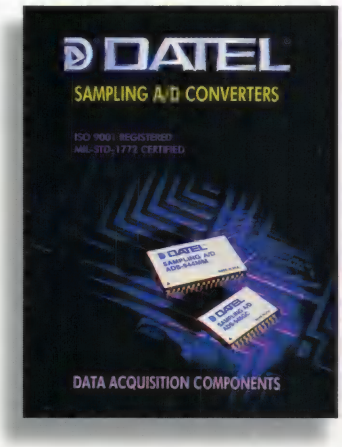

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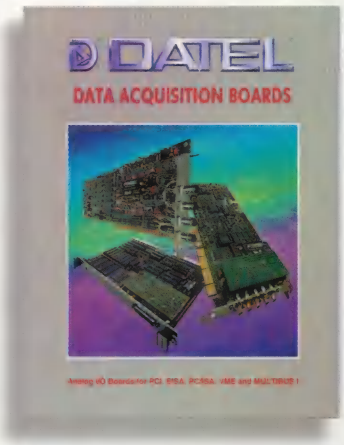

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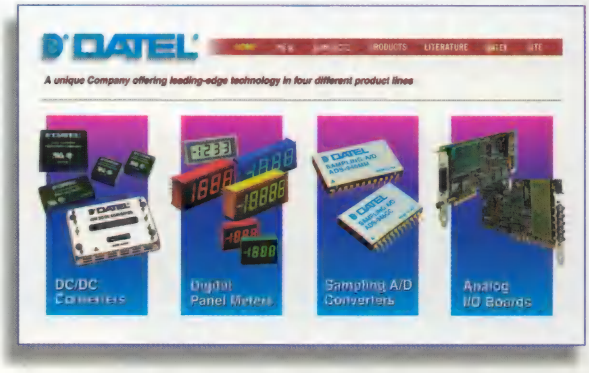

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DMS APPLICATION NOTE

The LED versus LCD Decision

Introduction

Users of contemporary digital panel meters (DPM's) have a variety of options available to them. While options are nice, they invariably mean more choices have to be made. After determining what meter resolution one requires, the next most basic decision is usually which type of display to use — liquid crystal or light emitting diode?

Traditionally, liquid crystal displays (LCD's) have been the obvious choice for outdoor/daylight applications and/or for applications requiring extremely low power consumption (current drains less than 15mA). Light emitting diode (LED) displays, with their comparatively low light intensities and relatively high current drains, have been excluded from these more demanding applications.

Recent DATEL innovations, most notably the introduction of extremely low-power LED displays, have complicated the once straightforward, LED/LCD decision.

LED Displays

The majority of panel-meter applications can, and should, use LED displays for two reasons: LED's can be read from virtually any angle (LCD's have much more restricted viewing angles), and LED displays can be easily read from greater distances (assuming comparable digit sizes). Additionally, LED's are typically more durable than LCD's and can be used under more harsh environmental conditions. The response time of LCD's slows down noticeably as temperatures drop below 0°C (32°F). This effect is seen as a "ghosting" of segments (old data remains partially visible) after the display has been updated with new data. The response time of LED's is not visibly affected even at temperatures below –20°C.

LCD Displays

LCD digital panel meters should always be used when the meter has to be read in direct sunlight, i.e., when no shading of the display is possible. Even the newest, super bright, high-intensity, red LED's (similar to those used in DATEL LED meters with "RH" suffixes) get "washed out" when viewed in direct sunlight. These bright LED's become easily visible, however, when hoods or other shading devices are used.

Backlit LCD displays should be used if the meter is to be operated in both high and low-light conditions. DATEL uses reliable, long-life LED's as the light source in all of our backlit LCD meters. A "B" suffix added to the end of the DATEL model number specifies a backlit model.

Transflective displays (black segments on a light-green background) are featured on all backlit LCD meters. Reflective displays (black segments on a silver background) are used on non-backlit devices.

Backlighting detracts from the low-power appeal of LCD meters. Backlit models of DATEL's LCD meters typically draw 35mA from their +5/9V supply. Non-backlit LCD models typically draw 100's of microamps. Current drains for backlit models can be reduced with the installation of current-limiting series resistors between the supply and the backlighting pin. This results in a proportionately dimmer backlighting effect, however, effective compromises can usually be found. Refer to the individual product data sheets for more information on backlight dimming.

Portable Applications

Portable instruments, specifically battery-powered designs requiring continuous operation, should use LCD meters. This is particularly true if the current drain on the battery must be maintained below 1mA. As mentioned above, DATEL now offers low-power LED panel meters with current drains less than 10mA from a single +5V power supply. These low-power LED models usually have red displays and are designated with an "RL" suffix added to the end of the part number.

If continuous display operation is not required, the DMS-20PC-RL (3½ digits, subminiature package, low-power red LED display) has a DISPLAY ENABLE feature allowing users to dim or totally darken the LED's. In the dark mode, current drain of this meter is reduced to less than 0.5mA (500µA). Even at full brightness, the DMS-20PC-RL draws a mere 7mA. Low-power LED meters are available in both 3½ and 4½ digit resolutions and only from DATEL!

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DMS APPLICATION NOTE 2

Input Configurations, Power Supplies and Ground Loops

Single-Ended Inputs

Single-ended and differential inputs, though no different for digital meters than any other application, are always worth revisiting. Please refer to Figure 1, the simplified schematic for the DMS-30LCD 3½ digit DPM during the following discussion.

All input signals must effectively be applied to each meter's two input terminals: a "positive" (high-side) input and a "negative" (low-side) input. These connections are normally made to the meter's pin 11, (+) INPUT HI, and pin 12, (–) INPUT LO. A single-ended signal will always have one of these two input pins connected to, or at the same potential as, pin 3 (5V RETURN/– BATTERY). The +5V power supply itself is an obvious example of a single-ended signal (see Figures 2 and 3).

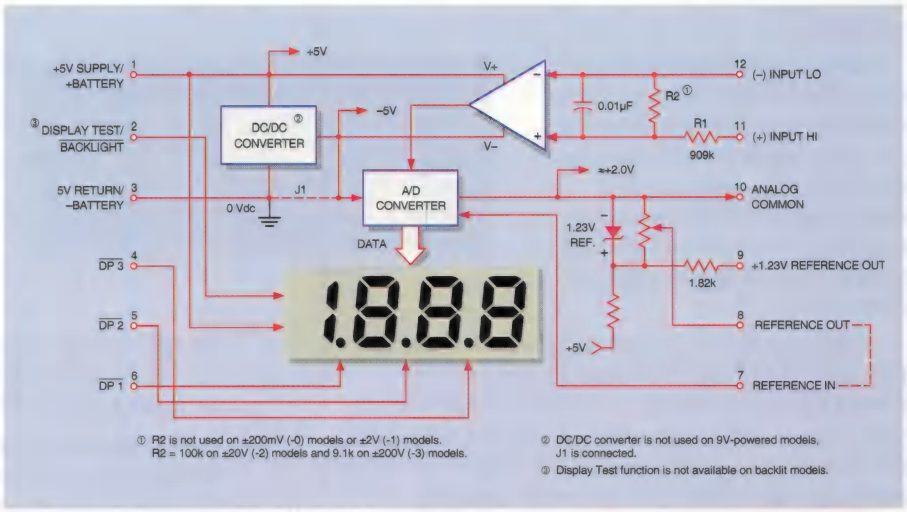

Figure 1. DMS-30LCD Simplified Schematic

Differential Inputs

A differential input signal is one that has both inputs at potentials other than that applied to pin 3 (5V RETURN/ –BATTERY). For example, the low input terminal (pin 12) could be at –1Vdc and the high input terminal (pin 11) at +0.9Vdc. Please note that in these instances, all voltages should be measured with an isolated voltmeter that has its negative lead (the black one) tied to pin 3 (0Vdc).

All 5V-powered DMS meters can be used to measure either single-ended or differential inputs. 9V-powered meters can only measure signals whose potentials are at least 1.5V above pin 3

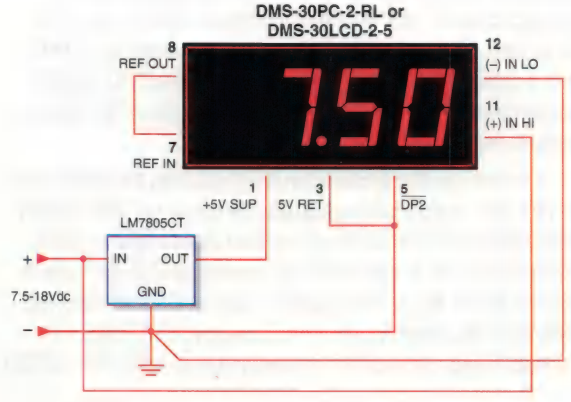

Figure 2. Three Terminal Regulator in Battery Monitor Circuit

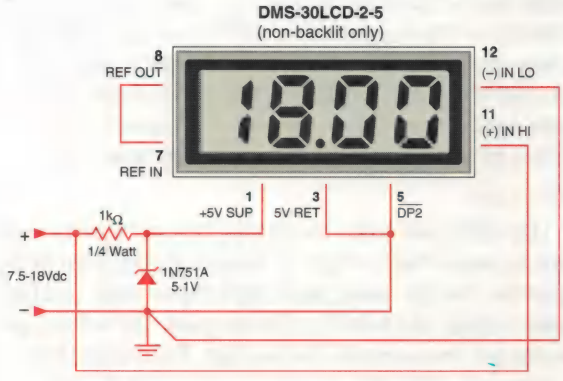

Figure 3. Zener Diode Regulator in Battery Monitor Circuit

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(–BATTERY) and at least 1.5V below pin 1 (+BATTERY). A 9V meter can not be used to measure the 1.9V differential signal referred to in the previous paragraph (0.9 –(–1.0) = 1.9V) since the pin with –1Vdc applied (pin 12, (–) INPUT LO) is more negative than pin 3.

9V-powered meters must never be wired in any configuration that has pin 11 or 12 tied directly to, or at the same potential as, pin 3. Doing so will drive the meter into an overrange condition (display flashes on and off or all digits are blank except for the left-most "1"). This condition is the number one cause of problems with 9V-powered LCD meters. How to solve it — or better still, avoid it — is covered next.

5V Regulators

In the real world of DPM's, there are many applications that are battery powered and also have their input signal referenced to, or even below, the negative battery terminal. In these applications, 5V-powered DMS meters must be used in order to avoid the above conditions. To accomplish this, the 9V battery must first be converted to a fairly clean, well regulated 5V. The two primary methods of accomplishing this are through the use of a three-terminal IC regulator or by using a zener diode in conjunction with a series limiting resistor. Figures 2 and 3 illustrate the two approaches.

The total power dissipation of all three components (LM7805, zener diode and series resistor) must be limited in order to prevent device overheating. The DMS-EB data sheet describes limitations to observe when using the LM7805. As a rule, non-backlit LCD meters can use the LM7805 with battery inputs up to 24Vdc.

Power Supply Considerations

The subject of power sources for DATEL's DMS Series digital panel voltmeters may, at first, appear to be a simple topic that could be covered in two short paragraphs. The first would discuss 5V-powered meters and the second, 9V-powered meters. In most applications, the choice is straightforward. Usually all that is available is either a +5V power source, normally derived from the ac line, or a battery in the 6-12V range. In the former case, when all you have is 5V, you should obviously strive to use a 5V-powered meter (either LED or LCD).

It is economically unwise, although one could do so, to use some type of DC/DC conversion and generate 9V solely for the sake of using a 9V-powered meter. Conversely, there are times when it is necessary to use 5V-powered models when the only available power source is the 6-12V battery mentioned earlier.

All DATEL DMS meters require stable, well regulated, dc power supplies in order to achieve their full specified performance. All models have an internal, 1-2 microfarad, filter capacitor connected across pin 1 (+5V SUPPLY/+BATTERY) and pin 3 (5V RETURN/ –BATTERY) to attenuate high-frequency noise. In most applications, this eliminates the need and additional expense of external decoupling capacitors. DC power sources with low-frequency (less than 1kHz) ripple and noise in excess of 50mV may induce instabilities in the meter's display and may require additional external power-supply filtering.

Ground Loops

"Ground loops" are another topic that deserves discussion because they rear their ugly heads all too often, especially when precision 4½ digit meters are used. Ground loops can cause both inaccurate and unstable readings. The display can "jump" up or down ("hunting") by as many as 20 counts. It will almost never read all "0's" with zero Volts applied.

A harmful ground loop can occur any time current which powers the meter's display (current entering or leaving pin 3) becomes intermixed with signal current (the current flowing in or out of pin 12). This usually occurs only with single-ended input signals due to the fact that (–) INPUT LO, pin 12, is normally connected to pin 3 (GROUND).

Figure 4 illustrates a common ground-loop condition and the associated voltages that cause the display inaccuracies. The error voltages are generated because all wiring that has current flowing through it has a voltage drop (referred to as the "IR" drop) between one end of the wiring and the other end.

The solution to the problem is simple: avoid connecting pin 12, (–) INPUT LO, directly to pin 3 in single-ended applications. Use a separate wire or pc-board trace, originating at the power and/or signal ground point, to tie (–) INPUT LO to zero Volts. Figure 5 shows how to correctly wire a single-ended signal.

LCD display meters are not normally sensitive to ground-loop induced errors. The total current drain of these models is usually less than 1mA (compared to 100mA or higher for their LED counterparts). It never hurts, however, to always use the wiring precautions described above, especially if backlit displays, with their significantly higher supply currents, are used.

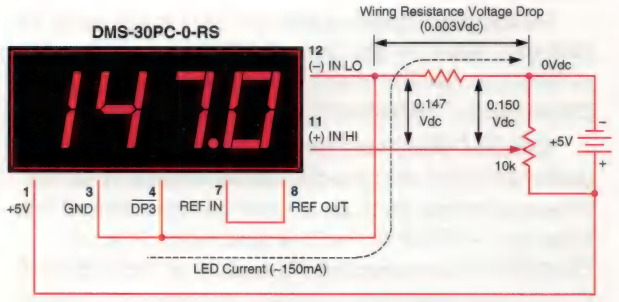

Figure 4. Single Ended Circuit with Ground-Loop Induced Errors.

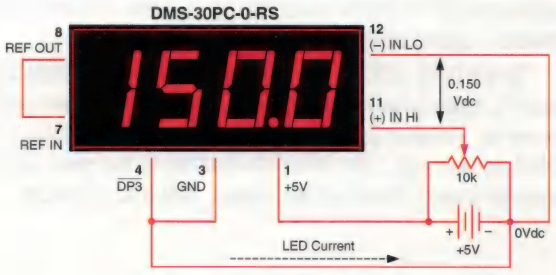

Figure 5. Correct Circuit Connections with No Ground-Loop Errors

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DMS APPLICATION NOTE 3

ANALOG COMMON and REFERENCE IN-OUT

ANALOG COMMON

Introduction

Perhaps the least understood I/O pin on all DMS Series DPM's is ANALOG COMMON (pin 10). The confusion surrounding this pin is not unjustified since **pin 10 should be left open, i.e., have no external connections, in the vast majority of normal meter applications**. Pin 10 should **not** be routinely connected to the power supply ground/common (pin 3), nor should it be connected to a system's signal (analog) ground/common.

Part of the confusion surrounding this pin arises from the fact that on some older DATEL DPM's, ANALOG COMMON must be connected to the system power supply common/return. This is not true for new DMS Series meters. In particular, never ground pin 10 on any DMS-20 Series meters or any of the 9V-powered meters in the DMS-30 or DMS-40 Series. Doing so will result in erroneous display readings.

General Description

The following discussion applies to all DMS models except the DMS-40PC Series (4½ digit DPM with LED display), i.e., it applies to all DMS-20 and DMS-30 models and to the LCD models of the DMS-40 Series. The DMS-40PC will be covered separately.

ANALOG COMMON is a low-noise internal "reference" voltage used by the meters' analog-to-digital converter (A/D or ADC). For 9V-powered meters, pin 10 sits at a potential approximately 3 Volts below pin 1 (+BATTERY). For 5V-powered meters, ANALOG COMMON will be approximately 2 Volts above pin 3 (5V RETURN). If the 5V power supply were to suddenly drop down to 4V, however, ANALOG COMMON would then only measure 1 Volt above pin 3.

Pin 1 (+5V SUPPLY/+BATTERY), not pin 3, should always be used as the reference point if measuring ANALOG COMMON. This applies to both 5V and 9V-powered models of both LED and LCD meters — again, with the exception of the DMS-40PC.

On the DMS-40PC, pin 10 is also called ANALOG COMMON, and it is, again, a low noise "reference" for the meter's internal A/D converter. However, on these models, ANALOG COMMON is in fact internally tied to pin 3 (5V RETURN/–BATTERY), the power supply common/ground. Even for these meters, ANALOG COMMON should not be externally connected to pin 3. Doing so will result in large LED currents flowing through pin 10 which can affect the A/D's reference point and cause highly unstable display readings.

Using Analog Common

So why, you may ask, is ANALOG COMMON user accessible? A quick look at the application note on ohmmeters (part of which is reproduced in Figure 1 below) reveals that ANALOG COMMON is used to provide a voltage reference point which is independent of variations in the 9V power source. Additionally, it provides a bias point, well above –BATTERY, to which (+) INPUT HI (pin 11) and (–) INPUT LO (pin 12) are referenced. Recall that for 9V-powered meters, these two inputs must be kept at least 1.5V away from either supply rail.

In the simplified schematic of the DMS-30PC shown in Figure 2, we see that REFERENCE OUT (pin 8) essentially has ANALOG COMMON as its negative terminal. If a user chooses to generate an external adjustable reference input, its negative terminal must also be connected to ANALOG COMMON.

External reference circuits should be designed so that the current drawn from pin 10 is maintained between 50 and 200 microamps. Recommended resistor values for this function can be found in the appropriate individual product data sheets.

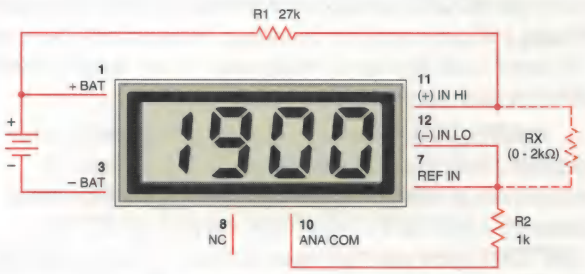

Figure 1. DMS-30LCD-0-9 in an Ohmmeter Application

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REFERENCE IN-OUT

Introduction

Occasionally, DATEL's application engineers receive questions regarding the use and functionality of pins 7 (REFERENCE IN) and 8 (REFERENCE OUT) on DMS Series voltmeters. The most often asked question is simply, "what do I do with pins 7 and 8?". For the majority of applications, the answer is straightforward: for all DMS-20 and DMS-30 Series meters, tie pins 7 and 8 together; for all DMS-40 series meters, leave them open.

Leaving pin 7 (REFERENCE IN) open on DMS-20 and DMS-30 meters will cause the meters to go into a permanent overrange condition. Connecting pin 7 to pin 8 on DMS-40 meters will result in gross errors in the display reading since pin 8 is a decimal point location pin (DP4).

General Description

The REFERENCE IN terminal determines the overall accuracy of the meter as the following equation illustrates:

$$\text{Display Reading} = (V_{IN} / V_{REF}) \times 1{,}000$$

This equation, which is effectively the transfer function of the meter, completely describes the meter's operation with a given input voltage. "Display Reading" is the number that will appear on the meter's LED/LCD readout. V_{IN} is the input voltage applied between (+) INPUT HI (pin 11) and (–) INPUT LO (pin 12). V_{REF} is the reference voltage applied to pin 7.

For all DMS-40 Series meters, V_{REF} = 1.000V. For DMS-20 and DMS-30 meters, with the exception of ±200mV input models, V_{REF} also equals 1.000Vdc. For the ±200mV models, V_{REF} = 0.100V.

The following example illustrates how the above equation defines meter operation assuming that V_{IN} = 1.234V and V_{REF} = 1.000V.

$$\text{Display Reading} = (1.234 / 1.000) \times 1{,}000 = 1234$$

If DP1 is enabled, the reading will be 1.234. It is clear from this example that an adjustable V_{REF} could be used to vary the display reading for whatever purpose the user may have (compensation for component tolerances, transducer errors, etc.).

All DMS Series meters have a built-in reference-adjust (gain-adjust) potentiometer, located on the back of the unit, which provides a narrow range of calibration adjustment. Its main purpose is to "fine tune" the display reading to accuracies better than those guaranteed on the device data sheets. For DMS-20 and DMS-30 applications that require larger changes in V_{REF} (on the order of ±2% to ±10%), consult the individual product data sheets.

Ratiometric Operation

Ratiometric operation is normally used to compensate for an input signal that continuously varies for one reason or another (unregulated power supply, temperature fluctuations, etc.). An external REFERENCE IN signal is generated that varies proportionately with the changes in the input signal. Ratiometric operation, while not a common application, can be easily implemented with either DMS-20 or DMS-30 Series meters.

When using these meters in a ratiometric configuration, ANALOG COMMON (pin 10) **must be used** as the external reference's low side. If the external reference uses the +5V RETURN (pin 3) as its low side, ANALOG COMMON can be grounded and the external reference simply tied to pin 7. This applies only to 5V-powered meters. Please note that only positive references can used, i.e., pin 7 must always be more positive than pin 10.

Some applications may require a DC/DC converter to provide isolation between the +5V powering the meter and the supply powering the input-signal electronics. Also note that ratiometric configurations, as well as external reference circuits, must **not** have pin 7 connected to pin 8.

The DMS-40PC and DMS-40LCD (4½ digit meters) have more complex internal reference circuitry, and though external gain adjustment circuits are possible, they also are more complicated. DATEL's application engineers will be more than happy to provide you with detailed information regarding the REFERENCE IN/OUT function on any DMS-40 meter

Once again, if your application requires ratiometric operation and you are using 9V-powered meters or any DMS-40 meter, we will provide you whatever assistance you may require.

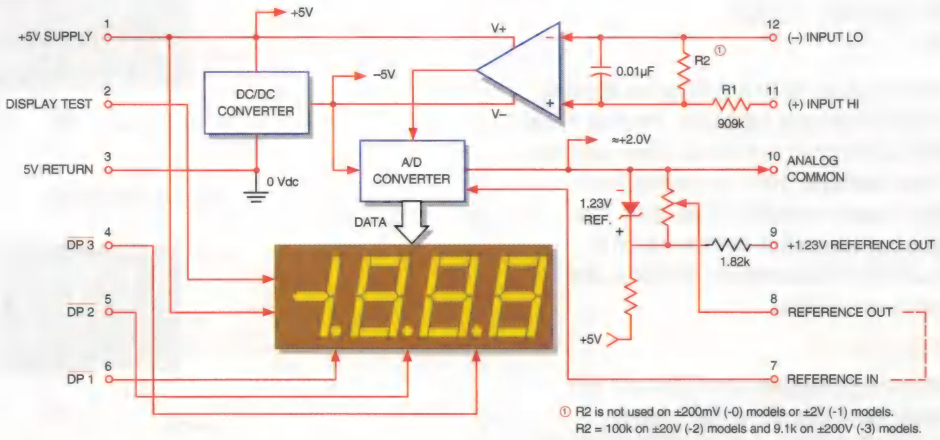

Figure 2. DMS-30PC Simplified Schematic

Engineering Scaling

Introduction

It is oftentimes necessary to attenuate "large" input signals down to a level that more closely matches the input range of a selected meter. For example, suppose the signal to be measured is 19 Volts, and the input voltage range of the available meter is 2 Volts (the preferred model for any attenuation circuit). Obviously, the "raw" input signal voltage is much too high for a ± 2V meter to measure directly and must first be attenuated.

The attenuation techniques and required connections for DMS-20-1, DMS-30-1 and DMS-40-1 meters are shown in Figures 1, 2 and 3. The recommended resistance value for R1 is 909kΩ. This is necessary in order to prevent excessive loading of the circuit producing the voltage (V_{IN}) being measured.

10:1 Attenuator

For this example, assume the desired display reading is "1900" for an applied input (V_{IN}) of 19 Volts. Under these conditions, the actual input to the meter (E1) must first be reduced to 1.900 Volts. If V_{IN} and E1 are known, and assuming a value of 909kΩ for R1, the value for R2 can be calculated from the following equation:

$$R2 = (E1 \times R1) / (V_{IN} - E1)$$
$$R2 = (1.9V \times 909{,}000) / (19 - 1.9)$$
$$R2 = 101k\Omega$$

The closest ±1% resistor value for R2 is 100kΩ.

If V_{IN} = 19V, R1 = 909kΩ and R2 = 100kΩ, the actual voltage at the meter's inputs (E1) is equal to:

$$E1 = (V_{IN} \times R2) / (R1 + R2)$$
$$E1 = (19 \times 100k) / (909{,}000 + 100{,}000)$$
$$E1 = 1.883 \text{ Volts}$$

Unfortunately, the above values for R1 and R2 do not attenuate the input to the exact desired voltage of 1.900 Volts. However, if one starts with the calculated values for R1 and R2, the display can then be changed to the desired reading of "1900" by adjusting the calibration potentiometer located on the back of the meter. This example is for illustrative purposes only. A 10:1 attenuation is already built-in on all ±20V DMS Series meters (-2 models), and they should be used whenever possible.

Attenuator Ratios Other Than 10:1

In real-world applications, the required attenuation ratio can have many different values other than 10:1 or 100:1, etc. For example, suppose we want the display to indicate "600" pounds (lb.) when V_{IN} equals 10 Volts. In order to have a reading of "600", the actual required input applied to the meter (E1) must be attenuated to 0.60 Volts. Knowing that V_{IN} = 10V, E1 = 0.6V, and assuming a value for R1 of 909kΩ, R2 can now be calculated:

$$R2 = (E1 \times R1) / (V_{IN} - E1)$$
$$R2 = (0.6V \times 909{,}000) / (10 - 0.6V)$$
$$R2 = 58.021k\Omega$$

The value of 58.021kΩ is not a standard ±1% resistor; the closest value is 57.6kΩ. Using a 57.6kΩ resistor for R2 gives a value for E1 of 0.595 Volts which is very close to the desired voltage of 0.6 Volts. Adjustment of the gain of the meter will be required for the display to read exactly "600" for the 10V input.

For additional information on selecting and using 1% resistors, see the application notes "Selecting 1% Resistors" and "Component Suppliers Listing".

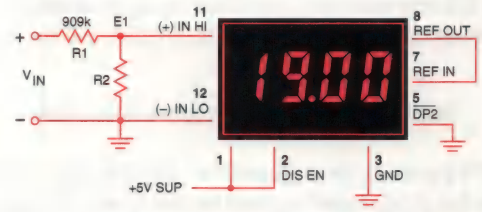

Figure 1. DMS-20PC-1

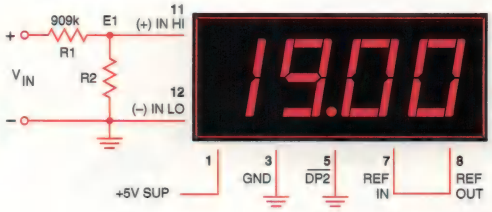

Figure 2. DMS-30PC-1

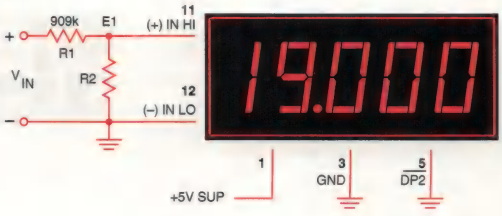

Figure 3. DMS-40PC-1

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Ohmmeter Circuits

Input Connections

The two diagrams below illustrate a simple technique for using the DMS-20 and DMS-30 Series 3½ digit DPM's as ohmmeters. For a measurement range of 0-200 Ohms, the value of R1 is 2.7kΩ and R2 = 100Ω (see Figure 1). For a measurement range of 0-2kΩ, R1 = 27kΩ and R2 = 1kΩ (see Figure 2). RX is the unknown resistance whose value is to be measured.

The accuracy and stability of the measurement is strictly a function of R2 only. If a ±5% resistor is used for R2, the overall accuracy of the ohmmeter will be ±5%. Precision, metal-film resistors, in series with a stable multi-turn potentiometer, should be used for R2 when the greatest accuracies are required. R1 is a current limiting resistor whose value is not critical to overall ohmmeter accuracy.

The connections from RX to pins 11 ((+) INPUT HI) and 12 ((–) INPUT LO) should be as short as possible to minimize errors from voltage (IR) drops. Removal of RX will result in the display showing "1– – –". This is the normal open-circuit indication for ohmmeters. When a short circuit is used for RX (simulating a zero Ohm resistor) most meters will display "000", however, this is highly dependent on careful wiring as previously noted.

Theory of Operation

To better understand how the circuit operates, assume that RX = 100Ω in the circuit of Figure 1. The voltage developed across R2 (also 100Ω) is equal to the voltage developed across RX since R2, RX and R1 form a series circuit. The meter's inputs are high impedance and draw negligible current. The circuit's transfer function (an equation that mathematically describes how the circuit operates) is:

$$\left(\frac{V_{IN}}{V_{REF}}\right) \times 1000 = \text{Display Reading}$$

Where: V_{IN} = Voltage drop across RX, V_{REF} is the voltage drop across R2. In this example, $V_{IN} = V_{REF}$ so the equation can also be written as:

(1) x 1000 = 100.0 (decimal point DP3 activated)

This type of circuit configuration has an upper resistance measurement limitation of 20kΩ. As the values of R1 and R2 are increased to change ranges, the amount of current available to develop a stable reference within the meter is reduced. For a 0-20kΩ range, the resistance required for R1 is 270kΩ and R2 is 10kΩ.

Summary

The meters that can be used in this application are the DMS-20PC-0, DMS-20LCD-0, DMS-30PC-0 and the DMS-30LCD-0. The "0" suffix on all these part numbers indicates that these meters have an input voltage range of ±200mV. 5V-powered meters are shown in the diagrams, but 9V-powered meters can also be used with no changes (except for the supply voltage) to the circuits or values of R1 and R2.

Figure 1. 0-200Ω Circuit (0.1Ω resolution)

Figure 2. 0-2kΩ Circuit (1Ω resolution)

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DMS APPLICATION NOTE 6

Direct Current Ammeters

Introduction

There is a trend to replace older, analog-style readouts with modern digital displays. As one might expect, the conversion is not always a trivial task. This is especially true when the conversion involves older, moving-vane ("pointer" style) analog ammeters. The typical analog ammeter has only two wires to contend with, and the required shunt resistor is sometimes built-in to the meter itself. By comparison, its digital replacement may have as many as five or six input terminals. The project gets even more complicated when you include the required external current shunt. Hopefully, after reading this application note, you will have the necessary information to avoid the most common pitfalls associated with digital ammeter installations.

Ammeter Theory

A digital ammeter is basically a very sensitive voltmeter with a typical input range of ±200mV (a DMS-30PC-0-RS for example). In order to convert the current to a voltage, the current must first pass through a device called a current shunt. A current shunt is a low-value resistor, usually one Ohm or less, that bypasses (or "shunts") the majority of the current flow around the meter.

Most current shunts have two pairs of terminals: one physically large pair to carry the load current and another smaller pair to carry the low-level signal voltage to the meter's input terminals (pins 11 and 12). The low-level signal connections do not require heavy-gauge wire. 22-26 AWG wire is sufficient since the current flow into the meter's input is extremely small. However, the load wires must be carefully chosen so as not to cause excessive heating and/or voltage drops. In most applications, the load wires also have to meet strict, electrical-code requirements. Questions on this type of installation must be referred to qualified personnel only.

Basic Ammeter Example

The circuit shown in Figure 1 illustrates a typical digital ammeter consisting of a +5Vdc power supply, a 0.1Ω current shunt, and a ±200mV-input DMS-30PC. The application is to measure the current supplied to a heater element which consumes one Amperein normal operation. This configuration poses no common mode voltage problems — more on this topic later in this application note — because the shunt is located in the power supply's ground terminal.

The easiest-to-use shunts have an output that is directly proportional to the current being measured, i.e., the shunt develops 100mV with 100 Amperes through it. This type of shunt requires no additional scaling or amplification. A 3½ digit meter with a 200mV input range will display "100.0", while a similar 2V-input meter, used with the same shunt, will display "100".

In Figure 1, the 0.1Ω shunt, with 1.0 Amperes through it, will develop 0.100Vdc or 100mV across it. The voltage developed across a shunt is calculated using Ohm's law as follows: the shunt voltage is equal to the current through the shunt (in Amperes) multiplied by the shunt's resistance (in Ohms) or V(shunt) = I(shunt) x R(shunt).

Practical Ammeter Examples

The circuit shown in Figure 1, unfortunately, does not depict the typical real-world ammeter connection scheme which has the current shunt located in the high side (positive terminal) of the system power supply. In Figure 1, the voltage across the shunt is only 0.1Vdc above pin 3 (5V RETURN). This is well below the ±2V common mode voltage limitation of the meter. Recall that all voltages at the meter's input terminals are measured with respect to pin 3.

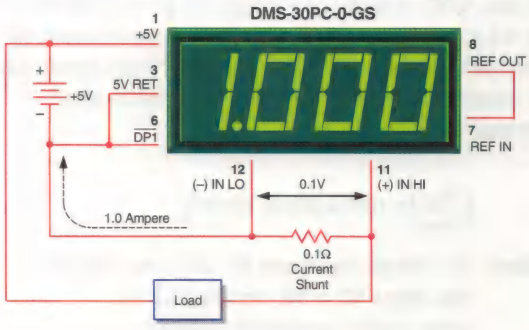

Figure 1. Basic Ammeter Circuit (Shunt in low side)

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Figure 2 differs from Figure 1 in one very important respect: the current shunt is located in the high side of the system power supply. As previously stated, this is the most popular — and the most troublesome — ammeter configuration in use. This type of hookup requires the use of a DC/DC converter to provide the necessary isolation between the meter's 5V power source and the system power supply. If the DC/DC converter is not used, the meter's inputs ((–)INPUT LO and (+)INPUT HI) will be at, or very close to, +5V. This condition violates the common-mode voltage limit of ±2V and will overrange the meter.

12V-Powered Ammeters

As a general rule, all ammeters using high-side current shunts must use an isolating DC/DC converter. Ignoring this rule could result in serious damage to the meter, particularly if power system voltages greater than +6Vdc are used. Systems that use two meters, one for Amperes, the other for Volts, even if a DC/DC converter is used, can still be troublesome.

Figure 3 shows the correct connections for a typical two-meter application. The DC/DC converter is required because the 0.1Ω current shunt is connected to the positive terminal of the 12V battery. If the shunt was connected in the negative side of the battery (low side), both meters could be powered from the LM7805CT regulator. The DC/DC converter would not be required. Please note that while the LM7805CT can power as many as 10 DMS-30PC-X-RL (low-power red LED) meters, it can only supply power to one standard-intensity DMS-30PC meter.

DMS-EB-DC/DC Application Board

DATEL's DMS-EB-DC/DC application board, with its built-in DC/DC converter, greatly simplifies the connections required for ammeters with high-side current shunts. As shipped, the DMS-EB-DC/DC board will provide an isolated 5V output from a 4.5-5.5V input. If only 12V power is available, the user can easily install an LM7805CT voltage regulator. See the DMS-EB-DC/DC data sheet for more information.

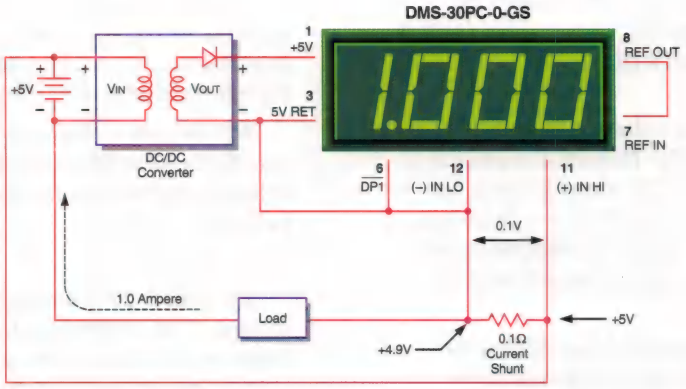

Figure 2. Basic Ammeter Circuit (Shunt in high side)

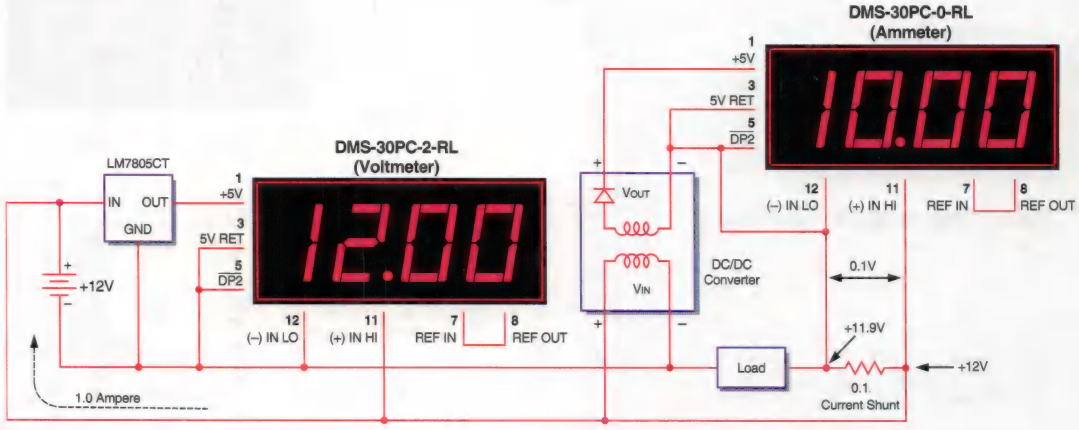

Figure 3. Measuring Amperes and Volts

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DMS APPLICATION NOTE 7

Implementing a Line Frequency Meter

Introduction

The circuits illustrated below can be used to measure an ac line frequency using the LM2917 frequency-to-voltage converter and DATEL's DMS Series digital voltmeters. The circuit in Figure 1 is used to provide isolation from the ac line. The transformer is a step-down type with a secondary voltage of 6.3Vrms. This voltage is rectified and applied to the resistive voltage divider consisting of R7 and R8. Figure 2 depicts the resulting waveform seen at the junction of R7 and R8. This voltage (F_{IN}), which will have a peak of approximately 1 Volt, is then applied to the input (pin 1) of the LM2917.

The circuit in Figure 3 will have a display reading of 60.0 for an input frequency of 60Hz. The 0.047µF capacitor (C1) should be a polyester type. The 47µF capacitor (C2) is used to reduce the output ripple of the LM2917. If the value of C2 is made too large, the ripple will be further reduced, however, the response time of the output for a given change in F_{IN} will take longer to reach its final value.

The 5kΩ potentiometer is a multi-turn type that allows for calibration between 50 to 60Hz. All other resistors should be precision, metal-film types with good temperature stability.

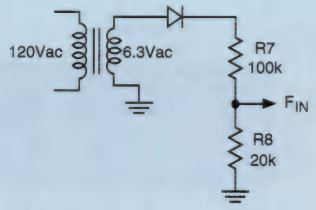

Figure 1. Input Isolation and Step Down

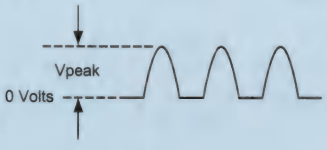

Figure 2. F_{IN} Waveform

Theory of Operation

The following equation is used to determine the output voltage (pin 3) of the LM2917:

$$V_{OUT} = (R1 + R2)\ (V_{CC})\ (C1)\ (F_{IN})$$

$$V_{OUT} = (25500 + 2850)\ (7.5)\ (47 \times 10^{-9})\ (60)$$

$$V_{OUT} = 0.6 \text{ Volts}$$

The value of V_{CC} used in the above equation is +7.5 Volts. This is due to the zener diode internal to the LM2917. The value for R2 is its adjusted value. It is used in the above equation for simplicity. The 0.6 Volts is applied to pin 11 ((+) INPUT HI) of the DMS meter.

With the meter configured as shown, the display reading for an input of 0.6V will be 60.0. R2 is adjusted as necessary until the desired display reading is obtained for a given input frequency to the LM2917.

Further Reading

The LM2917 ia an extremely versatile frequency-to-voltage converter IC. Its recommended source is National Semiconductor. Many more useful applications using the LM2917 can be found in National Semiconductor's Linear Applications Handbook, specifically in Application Note 162 (AN-162).

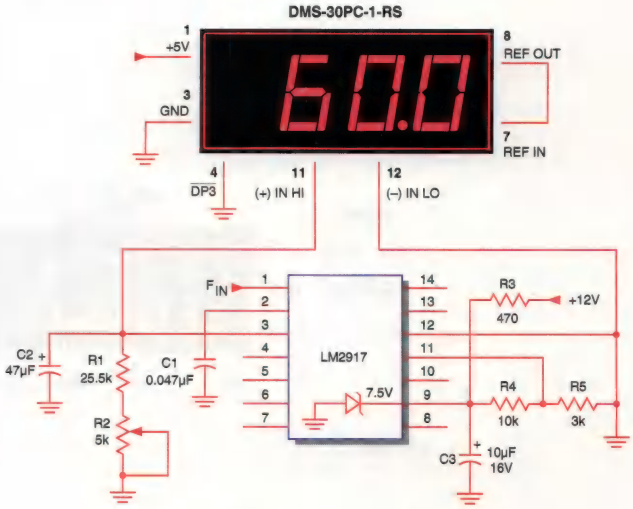

Figure 3. Line Frequency Meter

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DMS APPLICATION NOTE 8

Single-Component Thermometers

Introduction

The DMS-20 and DMS-30 Series of 3½ digit voltmeters are ideal for constructing very accurate digital thermometers with only a single external component—the LM34 or LM35 solid-state, temperature-transducer IC's. The LM34 and LM35, both available from National Semiconductor, are rugged three-terminal devices designed to make temperature measurements in degrees Fahrenheit or Celsius, respectively. They are both available in either TO-92 or TO-46 packages and cost approximately $2 (US) in 100-piece quantities.

The dc output voltage of both devices is linearly proportional to their ambient temperature, i.e., at +77°F (+25°C), the LM34's output is 0.77Vdc while the LM35's is 0.25Vdc. Neither device requires any external calibration or trimming circuits to provide typical accuracies of ±½°F (±¼°C) at room temperature and ±1½°F (±¾°C) over a full −50 to +300°F (−55 to +150°C) operating temperature range. However, although the LM34 and LM35 are specified to operate below 32°F (0°C), the DMS Series meters have an operating temperature range of 0 to +60°C (+32 to +140°F).

External Connections

As previously noted, it is very important that any meter used with the LM34/35 not be put into an environment that is outside the meter's specified operating temperature range. Care should be taken when making connections to the LM34/35. The point at which the wires attach to the LM34/35 should be kept at the same temperature as the body of the LM34/35. This will ensure that the connections themselves do not affect the overall measurement accuracy by acting as heat sinks and drawing heat away from the LM34/35's package.

Power Supply Requirements

Figure 1 shows the connections required for 5V-powered meters, while Figure 2 shows the connections for 9V-powered LCD meters. The input voltage range of all meters must be ±2 Volts ("-1" part number suffix). For 5V operation, any DMS-20, DMS-30 or DMS-40 model — with LCD or LED displays — can be used with either temperature sensor. For 9V operation, only the DMS-30LCD-1-9 can be used, and only with the connections shown in Figure 2. The 9V power source can either be a line-operated dc supply or a battery. The power requirement for the LM34/35 is typically 70µA while the DMS-30LCD-1-9 has a current drain of only 350µA.

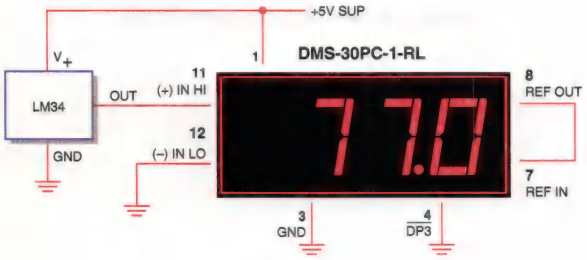

Figure 1. LM34 Fahrenheit Display Using DMS-30PC-1-RL

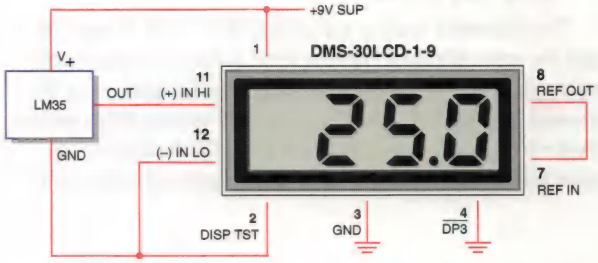

Figure 2. LM35 Celsius Display Using DMS-30LCD-1-9

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2000 RPM Tachometer

General Description

The circuit shown in the figure below will have a display reading of "1999" for an input frequency of 33.33Hz (equivalent to 1999 rpm). The 0.047µF capacitor (C1) should have a low-temperature-coefficient dielectric (polyester, polycarbonate and polypropylene are adequate for most applications). The 47µF capacitor (C2) is used to reduce the output ripple of the LM2917. If this value is made too large, the output ripple will be smaller, however, the response time of the LM2917 output (pin 3), for a given change in F_{IN}, will be longer. The 50k multi-turn potentiometer allows for overall calibration of the circuit's output at 1999 rpm. All fixed resistors should be metal-film types for good temperature stability.

Theory of Operation

The equation below is used to determine the LM2917's output voltage (pin 3) which is connected to the DMS-30PC's (+) INPUT HI terminal (assume the 50k potentiometer is set to 0Ω):

$$V_{OUT} = (R1 + R2)(Vcc)(C1)(F_{IN})$$
$$V_{OUT} = (150 \times 10^{3})(7.5)(47 \times 10^{-9})(33.33) = 1.762Vdc$$

The 50k potentiometer is adjusted so the meter's display reads "1999" at 1999 RPM.

The differential inputs of the LM2917 (pins 1 and 11) give the user the option of setting the input signal triggering level while still maintaining hysteresis around that point for noise rejection. In this example, this function is achieved with the 10kΩ and 200Ω resistor divider (R4 and R5). Pins 1 and 11 of the LM2917 should not be taken below ground or above the supply voltage on pin 9 (+7.5V).

To ensure proper input frequency sensing, the voltage applied to pin 11 of the LM2917 should be at least 100mV above the lowest input voltage normally applied to pin 1 (F_{IN}). Please refer to the LM2917 data sheet (available from National Semiconductor) for more information.

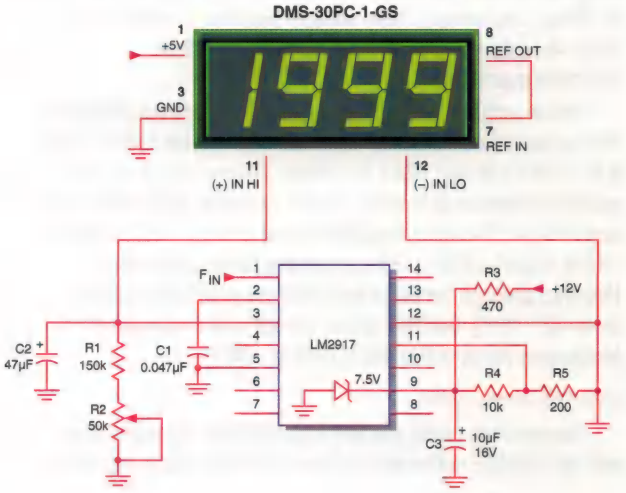

Figure 1. 0-1999 RPM Tachometer Circuit

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DMS APPLICATION NOTE 10

Minimum-Component Battery Monitors

Introduction

Many applications require that the system power supply voltage be precisely monitored. This is especially true when the equipment is battery operated, since battery voltage can be used as a measure of remaining battery capacity. Three, simple, energy-efficient ways to monitor a dc voltage source are shown in the figures below.

Using LCD Display Meters

The following meters can all be used for this application: DMS-20LCD-1-9, DMS-30LCD-1-9 and DMS-40LCD-0/1-9. All are 7.5 to 14V-powered meters featuring very low current consumption and input ranges of ±2V. In Figure 1, resistors R1, R2 and R3 make up a precision 10:1 voltage divider. Three resistors are required because 9V-powered meters can only make differential measurements. Pin 12 ((–) INPUT LO) can never be tied directly to the negative battery terminal (pin 3).

If we assume that the battery voltage in the following figures measures exactly 9.00V, then the differential voltage drop across R2 is 1/10 of 9.0V or 0.90V. DP2 is turned on to make it appear that the meter is measuring 9.00 Volts. Note that selecting a different decimal point does not change the input range of the meter.

Using LED Display Meters

It is also possible, with some additional circuitry, to use LED display, DMS Series voltmeters as battery monitors. The following LED meters can be used for battery monitoring: DMS-20PC-2-RL, DMS-30PC-2-RL and DMS-40PC-2-RL. These models all have built-in precision 10/1 dividers in their input stage. The primary disadvantage of using an LED display meter is the increased current required for powering the display itself — current that in many applications can not be ignored. Because of this increased LED current drain, only red low-power models (-RL suffixes) are recommended for use in power-sensitive configurations. Additionally, a regulated 5V power source must be generated since LED meters are only available as 5V-powered devices. As shown in Figures 2 and 3, the LM7805CT three-terminal regulator, in a TO-220 package, is used to generate the 5V power for the meter.

The battery voltage is applied to the input of the regulator and also to the input of the meter. For prototype purposes, DATEL's DMS-EB (for DMS-30PC and DMS-40PC meters) and DMS-EB2 (for DMS-20PC meters) Application Boards contain the required pc-board traces to mount the LM7805. If reverse-polarity protection is required, a 1N4001 or similar general-pupose silicon diode can be placed in series with the LM7805 (between the "+" battery terminal and the regulator). However, pin 11 ((+) INPUT HI) must still be tied directly to the battery's "+" terminal.

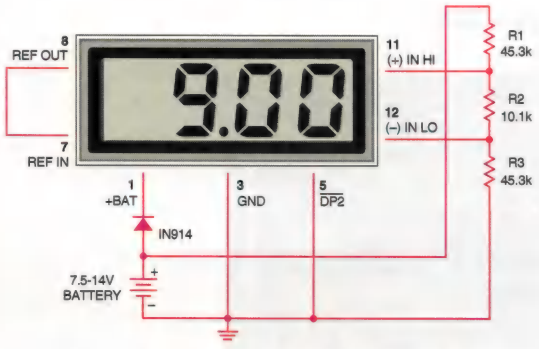
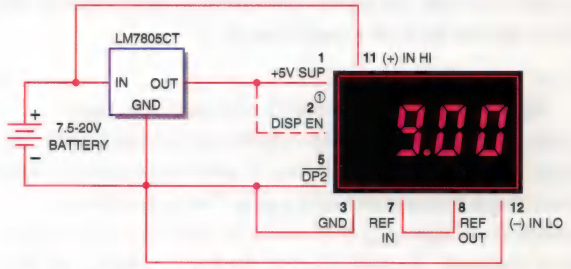


Figure 1. Connections for the DMS-20LCD-1-9 and the DMS-30LCD-1-9



① Pin 2 connected on DMS-20PC-2-RL only.

Figure 2. Connections for the DMS-20PC-2-RL and the DMS-30PC-2-RL

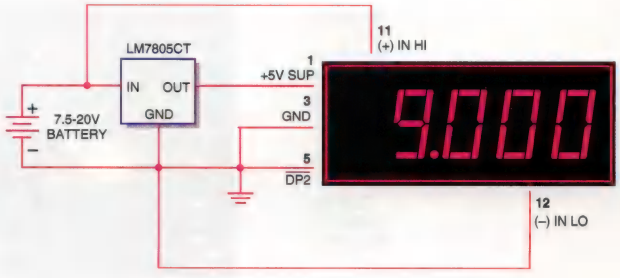


Figure 3. Connections for the DMS-40PC-2-RL

6

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DMS APPLICATION NOTE 11

Using the DMS-EB-RMS Board

General Description

When soldered to a 2V-input, 3½ digit DMS-30 Series meter, the DMS-EB-RMS Application Board enables the meter to display the true rms value of ac voltages up to 750V with a resolution of 1V. When the board is soldered to a 200mV-input DMS-30 meter, ac voltages up to 199.9V can be displayed with 0.1V resolution. The DMS-EB-RMS board will operate with either LED display (DMS-30PC) or 5V-powered LCD display (DMS-30LCD) meters.

As shown in Figure 2, a 1000:1 voltage divider consisting of resistors R1 (988k), R2 (988k) and R3 (1.98k) is used to attenuate the ac input to a level that U1 can accept. U1 is a precision, integrated circuit, ac-to-rms converter whose dc output is directly applied to the DMS-30's input.

As an example, assume a 120Vrms, 60Hz, ac power-line input is applied to TB1 terminals 1 and 3. This input is divided down to 0.120Vrms and then applied to U1. If the selected DMS-30 meter has a ±2V input range (-1 suffix), the display reading will be "120" (1Vac resolution). If the selected DMS-30 meter has an input range of ±200mV (-0 suffix), the display reading will be "120.0" (decimal point DP3 is enabled by shorting solder gap SG1).

Powering the DMS-EB-RMS

As stated in the DMS-EB-RMS's data sheet, a dedicated, transformer-isolated, +5V power supply must be used to power the DMS-EB-RMS and its meter in order to ensure safe operation when measuring ac power mains input signals. The transformer's breakdown voltage rating must always be higher than the ac input being measured. The DMS-EB-RMS provides no isolation between the ac input signal and the meter's 5V RETURN terminal. Take extreme care when connecting any ac power mains source as an input signal to the DMS-EB-RMS. Never connect the DMS-EB-RMS's 5V RETURN terminal to earth (chassis) ground since this could defeat any safety grounding and place the system's +5V power supply, and all its associated circuitry, at dangerously elevated ac-line potentials.

The only time the above precautions may be deviated from is if the input signal is either transformer-coupled or electrically isolated from the ac power line. The output of a current transformer (used for making ac amperage measurements) is an example of an ac signal that normally exceeds the isolation requirements stated earlier. Do not hesitate to consult DATEL if you have questions regarding any aspect of your DMS-EB-RMS application.

Modifying the DMS-EB-RMS's Input Circuit

The 1000:1 input divider described above can be altered or removed altogether to suit the user's particular input requirements. However, in all cases, the maximum voltage that can be applied to U1's V_{IN} terminal (pin 2) is 1.0Vac. For example, to display a 0 to 1Vac input with 1mV resolution, a jumper wire (JP1) can be used to effectively short R1 and R2 (see Figure 1). In applications in which R1 and R2 are shorted, R3 should also be removed from the circuit because it may load down the signal source. With this configuration and an input of 1.0Vac, a DMS-30PC-1 meter (±2V input) will display "1.000".

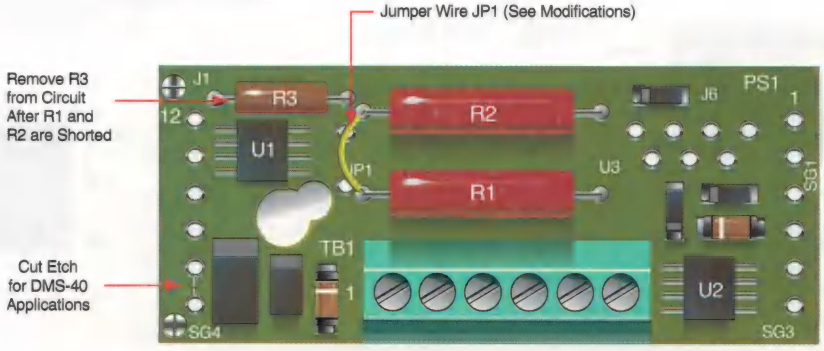

Figure 1. Modifying the DMS-EB-RMS Application Board

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As another example, assume that the input signal range is 0 to 10Vac. A 10Vac input is too high to be applied directly to U1; it must first be divided by a factor of 10 to obtain a level of 1.0Vac at U1 pin 2. This can easily be accomplished by leaving R1 and R2 in the circuit and replacing R3 with a precision, ±0.1%, 221k resistor. A DMS-30PC-1 meter will now read "10.00" for an input of 10Vac. The appropriate decimal point is enabled via the on-board solder gaps: DP1 in the first example and DP2 in the second example.

Eliminating DC Components

To measure the ac component of a signal that is "riding on top" of a dc voltage, the ac input to the DMS-EB-RMS must be capacitively coupled. The capacitor value chosen should produce negligible capacitive reactance (impedance) at the lowest frequency of interest. A 0.1µF ceramic or film capacitor can be used with 120-220Vac, 50/60Hz inputs. The minimum voltage rating of the coupling capacitor is determined by first finding the sum of the peak ac signal plus its dc component, and then multiplying this sum by a safety factor of 1.5. The coupling capacitor is installed in series with TB1 and the ac input. One capacitor lead is attached directly to TB1 terminal 1 and the other lead soldered to the ac input.

DMS-40 Applications

The DMS-EB-RMS board can be used with 4½ digit DMS-40PC-1-RS (2V input, LED display) or DMS-40LCD-1/2-5 (2V input, 5V-powered, LCD display) voltmeters by simply cutting the etch between pins 7 and 8 as shown in Figure 1. This removes the short circuit between REF. OUT and REF. IN which is needed for DMS-30 Series meters. SG4, SG1, SG2, and SG3 are used to select decimal points DP4, DP3, DP2 and DP1, respectively.

Calibration Access Holes

The DMS-EB-RMS board now has two overlapping holes which provide access to the DMS-30 and DMS-40 meters' rear calibration adjustment potentiometers. In many applications, particularly those involving modifications to the board's 1000:1 input resistor divider, these pots can be adjusted to obtain higher accuracy than the specified ±0.5% in the 0-199.9Vac mode or the ±2% in the 0-750Vac mode.

The mechanical adjustment range of these potentiometers is only ¾ of a turn on DMS-30 meters and 3 turns on DMS-40 meters. DMS-30 pots have fixed end-stops, DMS-40's do not. Therefore, do not use excessive force when making adjustments. Use extreme caution and plastic insulated tools since adjustments have to be made with the DMS-EB-RMS fully energized.

Other DMS-EB-RMS Components

The DMS-EB-RMS board layout was recently updated to include circuitry for many new features: an on-board +5V dc/dc converter (PS1); an LM7805 three-terminal linear regulator (U3); surface mount pads under R1 and R2; solder gap SG4 for decimal point DP4 on DMS-40 meters; and the calibration potentiometer access holes described earlier.

PS1 will support a transformer-isolated, +5V power supply (required when making ac power mains measurements) to be mounted directly on the DMS-EB-RMS itself. U3, the location for an LM7805 regulator, will allow for operation from power sources other than the standard +5Vdc.

Please consult DATEL for more information regarding availability and use of any of the new components or features of the DMS-EB-RMS board. DATEL's Internet web site, **www.datel.com**, and our automated fax system (in the USA, 508-261-2857) are both excellent sources for obtaining the latest revision of product data sheets and/or applications information.

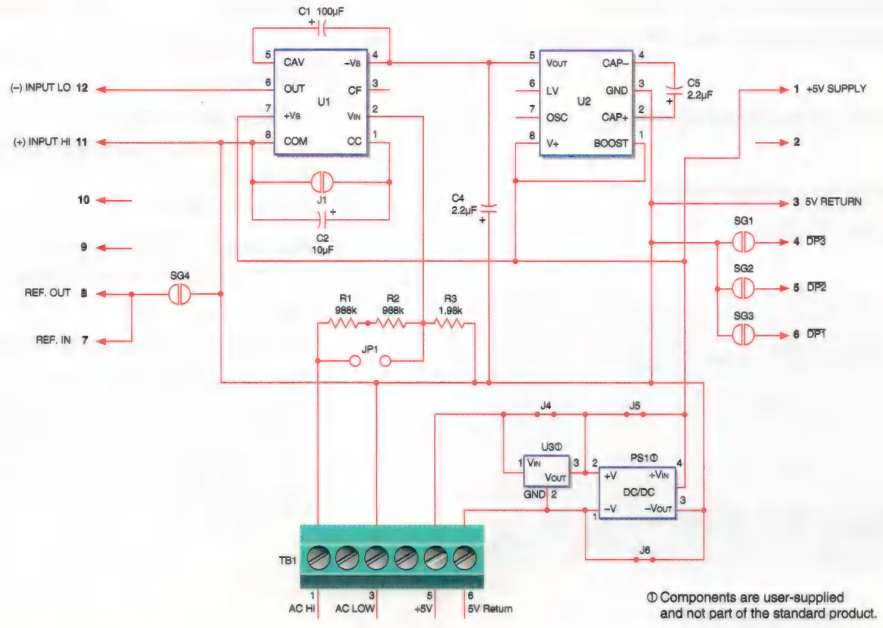

Figure 2. Powering the DMS-EB-RMS

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DMS APPLICATION NOTE 12

Signals with Zero Offsets

Introduction

Many transducer outputs exhibit a dc offset voltage when the output level would normally be expected to be zero Volts (corresponding to a display reading of "000"). As an example, consider a pressure transducer whose output levels of 1.0Vdc to 6.0Vdc are required to produce display readings of "000" to "400" respectively. To obtain the desired readings, the 1-6V signal has to be attenuated first, and then its 1V offset voltage must be subtracted or nulled to zero.

Attenuating the Input

The resistor divider shown in Figure 1 easily accomplishes the task of reducing the raw input signal (V_{IN}) down to a level which a ±2V-input meter (DMS-30PC-1-RS for example) can accept. However, the attenuated signal (Vatten) at pin 11 ((+) INPUT HI) still has a dc offset which has to be nulled. The following procedure can be used with many other input-voltage/display-reading combinations. Two completely worked-out examples will be provided.

The DMS-EB Application Board for DMS-30 Series meters has locations for installing the required user-supplied components shown in Figures 1 and 2. For large OEM requirements, DATEL can provide a completely wired and tested meter to suit your particular requirements. Please consult our sales or marketing engineers for more information.

Example 1. A 1-6V input signal must be conditioned to display "000" to "400".

Step 1. Find the differential input voltage V_{IN} (diff):

V_{IN} (diff) = V_{IN} (max) - V_{IN} (min)

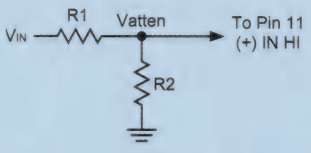

Figure 1. Resistor Divider

Where V_{IN} is the raw input voltage (1V to 6V) and V_{IN} (diff) is the differential raw input voltage. In this example, V_{IN} (max) = 6V and V_{IN} (min) = 1V. The result is as follows:

V_{IN} (diff) = 6V - 1V = 5V

Step 2. Use the required display readings for V_{IN} (min) and V_{IN} (max) to find Vatten(diff):

In this example, when V_{IN} (min) = 1V, the display must read "000", and when V_{IN} (max) = 6V, the display must read "400". The following equation defines Vatten(diff):

Vatten(diff) = Vatten(diffhi) - Vatten(difflo)

Where Vatten(diffhi) and Vatten(difflo) are the respective high and low differential voltages (measured between the meter's pins 11 and 12) needed for the highest display reading (0.400V to read "400") and the lowest display reading (0.0V to read "000"), assuming a meter with a ±2V input range is used.

Vatten(diff) = Vatten(diffhi) - Vatten(difflo)
Vatten(diff) = 0.400V - 0.000V = 0.400V

Step 3. Find the input attenuator ratio r, and then use r to find R2 (see Figure 1):

r = Vatten(diff) / V_{IN}(diff)
Substitute the previously calculated values for Vatten(diff) and V_{IN}(diff):
r = 0.400V / 5V = 0.08

Assuming R1 = 909kΩ and using the calculated value of 0.08 for r, solve the equation below to find R2:

R2 = [r / (1 – r)] x R1
R2 = [0.08 / (1 – 0.08)] x 909,000 = 79,043Ω

The nearest ±1% resistor is 78.7kΩ. The assumed R1 value of 909kΩ is an arbitrary one, however, it does keep the attenuation circuit's impedance near 1MΩ and should reduce any loading the meter may have on the input signal source (V_{IN}).

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Step 4. Find the null voltage that must be applied to pin 12 ((–) INPUT LO, see Figure 2):

Please note that all voltages in this step are single-ended values (measured with respect to pin 3, 5V RETURN). The primary goal of this step is to illustrate that all the calculations above actually work! The following two equations will be used:

Vatten(max) = r x V_{IN}(max) and Vatten(min) = r x V_{IN}(min)

Substituting values produces the following results:

Vatten(min) = 0.08 x 1.0V = 0.08V, and
Vatten(max) = 0.08 x 6.0V = 0.480V

When V_{IN} is 1V, Vatten(min) will be 0.08V. It must be nulled by also placing 0.080V on pin 12 ((–) INPUT LO) in order to achieve a display reading of "000". The circuit shown in Figure 2 uses a precision 22-turn potentiometer (R5) to generate 0.08V of zero offset.

When V_{IN} is 6V, Vatten will be 0.48V, however, the meter will display the difference between pins 11 and 12: 0.48V-0.08V = 0.400V (a reading of "400").

Step 5. Calibrate the circuit:

Apply a 1.0V input (V_{IN}) and adjust R5 (zero adjust) so the display reads "000". Apply 6.0V and adjust R4 (gain adjust) so the display reads "400". The decimal points (DP1-DP3) have not been mentioned above because they are strictly place holders.

Example 2. A 1-5V input must display "200" to "1200".

Step 1. Find the differential input voltage V_{IN} (diff):

V_{IN}(diff) = V_{IN}(max) - V_{IN}(min)
V_{IN}(diff) = 5V-1V = 4V

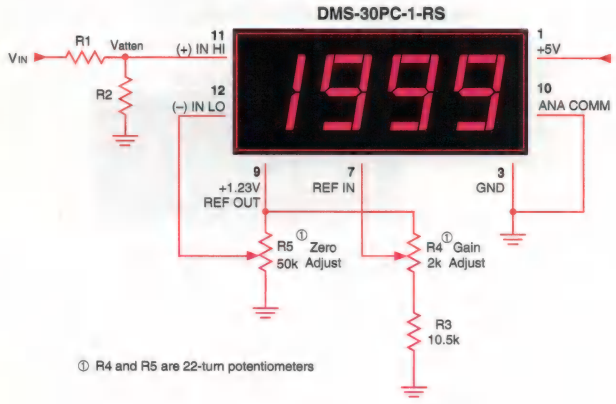

Figure 2. Schematic Diagram

Step 2. Use the required display readings for V_{IN}(min) and V_{IN}(max) to find Vatten(diff):

In this example, when V_{IN}(min) = 1V, the display must read "200", and when V_{IN}(max) = 6V, the display must read "1200":

Vatten(diff) = Vatten(diffhi) - Vatten(difflo)
Vatten(diff) = 1.200V-0.200V = 1.000V

Recall that Vatten(diffhi) is the differential voltage between pins 11 and 12 required to display "1200", and Vatten(difflo) is the differential voltage which will display "200".

Step 3. Find the input divider ratio r, and then use r to find R2:

r = Vatten(diff) / V_{IN}(diff)
r = 1V / 4V = 0.25
Again, assuming R1 = 909kΩ, find R2:
R2 = [r / (1 – r)] x R1
R2 = [0.25 / (1 – 0.25)] x 909,000 = 303,000Ω
The closest ±1% resistor is 301kΩ.

Step 4. Find the null voltage that must be applied to (–) INPUT LO (pin 12):

Vatten(min) = r x V_{IN}(min) and Vatten(max) = r x V_{IN}(max)
Substituting values gives the following results:
Vatten(min) = 0.25 x 1V = 0.25V, and
Vatten(max) = 0.25 x 5V = 1.25V

If we examine the min. and max. Vatten values above, 0.250V and 1.250V, we notice that they are only 0.05V above the desired display readings of "200" (or 0.200V) and "1200" (or 1.200V). The required zero-offset voltage will be near, but not exactly, 0.05V.

Step 5. Calibrate the circuit:

The calibration of this example differs from the procedure used in Example 1. In this application, the offset potentiometer (R5) and the gain potentiometer (R4) interact with one another. It is very important to perform the calibration in the sequence presented below.

First, apply a 1.0V input and adjust R5 to its maximum clockwise or counterclockwise position in order to obtain the highest positive display reading (approximately "240" in this example). Next, apply a 5.0V input and adjust the gain potentiometer R4 so the display reads exactly "1250". Then, apply a 1.0V input and adjust R5 so the display reads exactly "200". Lastly, apply a 5.0V input. The display should now read "1200". Re-apply both V_{IN} settings (1V and 5V) to make sure the adjustments did not adversely affect one another. Perform minor adjustments if necessary. This ap note for NGT.

Decimal Point Drivers

The most common technique for activating a single decimal point is simply tieing its activation pin to ground. In most situations, only one decimal point is used because the display reading represents only one parameter. However, some applications require the use of more than one decimal point in order indicate a different range, or perhaps, have the reading represent some other system parameter. A simple rotary switch can be used with any DMS meter when two or more different decimal point selections are required. The rotary switch method is illustrated in Figure 1.

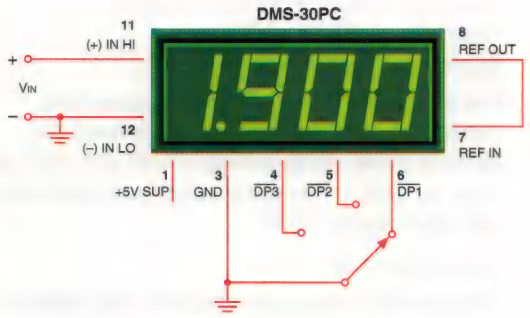

Figure 1. Simple selector switch can be used with all DMS Series panel meters.

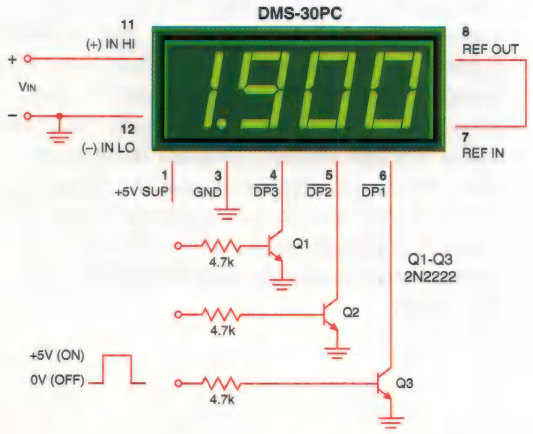

Figure 2. NPN transistors can be used with all 5V-powered, 3½ and 4½ digit, DMS panel meters.

Other components that can be used for decimal point drivers, particularly when dynamic control is required, are TTL or CMOS-compatible logic gates/buffers and open-collector/open-drain discrete transistors. The maximum current the driving device must sink is 20mA (see individual product data sheets for more specific data). The following diagrams illustrate the various techniques that can be used for driving the decimal points on all DMS Series meters.

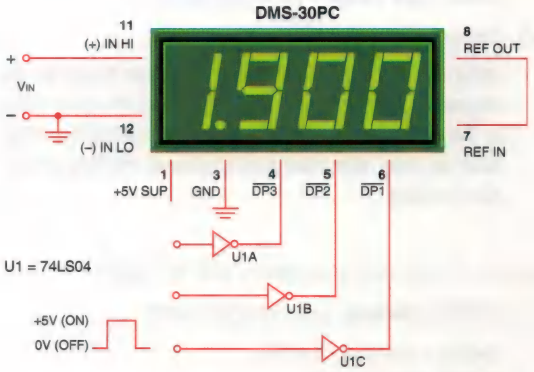

Figure 3. Inverting gate decimal point drivers usable with 5V-powered 3½ digit DMS panel meters except models with blue LED displays.

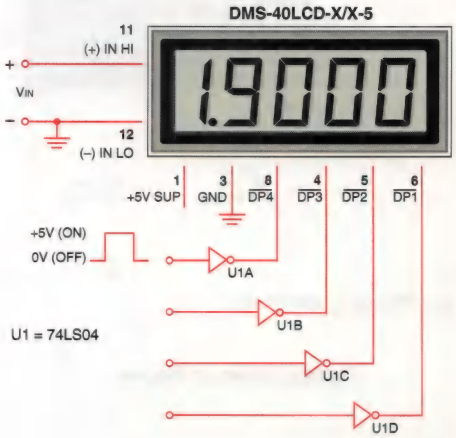

Figure 4. Inverting gate decimal point drivers usable with 5V-powered 4½ digit LCD and DMS-40PC-X-RL (low-power red LED's) panel meters.

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DMS APPLICATION NOTE 14

Selecting 1% Resistors

Introduction

Many of the application notes in this section make reference to, or specify the use of, ±1% metal-film resistors. The table below lists all readily available, E-96 series, 1% resistor values. Please see the component suppliers index for the name and address of 1% resistor suppliers.

Using the Table

Using the table is straightforward. First determine the required value. Then, using just the first three digits of the required value, find the closest number to the three digits in the table — disregard the decimal points for this step. For example, your calculations indicate that a 1,342Ω resistor is needed for an input-scaling circuit. The first three digits are "134". The closest value to 134 in the table is "13.3". Multiply 13.3 by 100. The result, 1,330Ω, is the closest commercially-available resistor value, commonly referred to as 1.33kΩ .

The total number of resistors available is not infinite; most manufacturers stock values from 10Ω through 10,000,000Ω (10 Megohm). This means you can apply multipliers of 1 (10^0) through 1,000,000 (10^6) to the numbers in the table. The most common wattage ratings are 1/8 and 1/4 Watt; though 1/2 and 1 Watt units are also available. Values above 1 Megohm are usually more available in ratings of 1/4 Watt or higher.

Voltage Rating

Two other resistor parameters to be aware of are working voltage and temperature coefficient of resistance (TCR). Most 1/4-Watt resistors are rated for 200V continuous operation. 1/2 Watt and higher types can be obtained with ratings in excess of 500V. Resistor voltage ratings are a very important consideration when designing dividers with input voltages greater than 200Vdc or 120Vac. A safety-minded point to keep in mind when designing any type of input divider is to always use resistor values that add up to at least 1 Megohm. Doing so will generally allow the use of readily available 1/4-Watt resistors.

Temperature Coefficient

Applications using 3½ digit meters (DMS-30 and DMS-20) can use resistors with TCR's of 50 to 100ppm. TCR is normally specified in ppm/°C (parts per million per degree Centigrade). 4½ digit meters should use 25ppm, or better, resistors. To put this into terminology that is more easily understood, one count ("001") on the display of a DMS-20 meter is 500ppm. One count ("0001") on a DMS-40 meter is 50ppm!

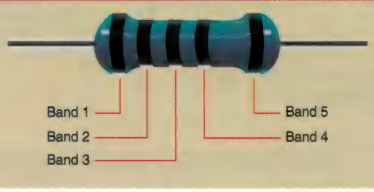
As a worst-case example, assume two ±100ppm resistors are used in a ten-to-one input divider for a DMS-40PC and the ambient temperature goes up by 2°C. If one resistor has a TCR of +100ppm and the other has a TCR of -100ppm, a total change of 200ppm/°C x 2°C = 400ppm would occur. Since one count on the display is 50ppm, the meter's reading would change by 400/50 = 8 counts. In some applications, 8 counts may be a very significant change!

E-96 (±1%) Decade Values Table

10.0	10.2	10.5	10.7	11.0	11.3	11.5	11.8
12.1	12.4	12.7	13.0	13.3	13.7	14.0	14.3
14.7	15.0	15.4	15.8	16.2	16.5	16.9	17.4
17.8	18.2	18.7	19.1	19.6	20.0	20.5	21.0
21.5	22.1	22.6	23.2	23.7	24.3	24.9	25.5
26.1	26.7	27.4	28.0	28.7	29.4	30.1	30.9
31.6	32.4	33.2	34.0	34.8	35.7	36.5	37.4
38.3	39.2	40.2	41.2	42.2	43.2	44.2	45.3
46.4	47.5	48.7	49.9	51.1	52.3	53.6	54.9
56.2	57.6	59.0	60.4	61.9	63.4	64.9	66.5
68.1	69.8	71.5	73.2	75.0	76.8	78.7	80.6
82.5	84.5	86.6	88.7	90.9	93.1	95.3	97.6

E-96 Color Code Table

Color	Band 1	Band 2	Band 3	Band 4	Band 5
Black	0	0	0	10^0	
Brown	1	1	1	10^1	±1%
Red	2	2	2	10^2	
Orange	3	3	3	10^3	
Yellow	4	4	4	10^4	
Green	5	5	5	10^5	±0.5%
Blue	6	6	6	10^6	±0.25%
Violet	7	7	7	10^7	±0.1%
Gray	8	8	8	10^8	
White	9	9	9	10^9	
Gold				10^{-1}	



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DMS APPLICATION NOTE 15

Troubleshooting Guide

Though panel meters are not very complex components, the real-world situations in which they are used are not always that straightforward. Though we have attempted to clearly describe a number of the more popular DPM applications, it is inevitable that your particular application will have its own little idiosyncracies and challenges.

The following troubleshooting guide — while obviously not guaranteed to solve every problem — should prove useful, particularly to first-time users of DATEL's DMS Series DPM's. Where applicable, we have referenced DATEL Application Notes that may provide additional clarifications, alternatives or other helpful insights. The most likely "possible causes" of a particular problem are listed first with the least likely ones listed later.

Some simple "self-tests" are also included to assist in determining whether or not a meter has suffered irreparable damage (i. e., "blown"). The self-tests are particularly useful if dc voltage calibrators, digital multimeters (DMM's), or similar troubleshooting instruments are not readily available. Testing is usually more effectively performed with the meter disconnected from the circuit in question.

If problems persist, please don't hesitate to call DATEL's experienced application engineers at either 508-339-3000 or 800-233-2765.

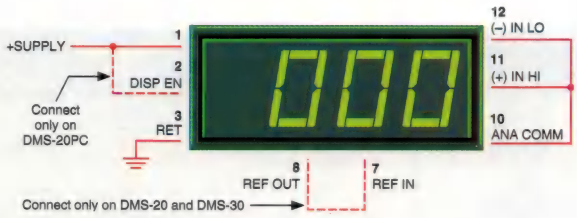

Figure 1. Self-Test Circuit (Zero Test)

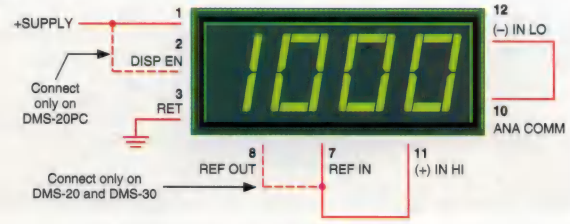

Figure 2. Self-Test Circuit (Reference Test)

Dead (off) display

1. Power may be connected incorrectly (reverse polarity?). Verify connections at meter with a DMM.
2. On DMS-20PC models, pin 2 (DISPLAY ENABLE) may be open.
3. Meter may be blown or defective (see self-tests).

See individual product data sheets.

Display permanently overranged

1. Pin 7 (REFERENCE IN) may be open (DMS-20/30 only).
2. 9V models may be incorrectly used in single-ended mode.
3. Input voltage range may be exceeded.
4. Common mode voltage may exceed power supply voltage.
5. Meter may be blown or defective (see self-tests).

See application notes 2 and 3.

Display intermittently overranges

1. Pins 11 and/or 12 (INPUTS) may be open (no connections).
2. Input signal may be "floating". For 5V models, tie pin 12 (–INPUT LO) to pin 3 (5V RETURN). For 9V models, tie pin 12 to pin 10 (ANALOG COMMON).
3. Input may not be a steady dc voltage.
4. Pin 7 (REFERENCE IN) may be open (DMS-20/30 only).

See individual product data sheets & ap notes 2, 3 and 11.

All readings low

1. Pin 10 (ANALOG COMMON) may be grounded (DMS-20's only).
2. Pin 9 (+1.23V REFERENCE OUT) may be incorrectly tied to pins 7 and 8 (REFERENCE IN/OUT) (DMS-30's only).
3. Pin 8 may be incorrectly tied to pin 7 (DMS-40's).
4. Gain potentiometer on back of meter may be misadjusted.
5. Wrong input range (too high) possibly being used.
6. Wrong input range may have been selected (DMS-40LCD only).

See application notes 3 and 4.

Display will not read "000"

1. Input may not be at 0.0V (has some zero offset).
2. There may be ground loops in input signal wiring.

See application notes 2, 3 and 12.

Erratic (unsteady) readings

1. There may be ground loops in the input/power system wiring.
2. Pin 10 (ANALOG COMMON) may be incorrectly tied to pin 3 (5V RETURN)(DMS-40PC).
3. Power source may be poorly regulated.
4. Input signal may have excessive ac components.
5. There may be strong magnetic or electrostatic fields near the meter.

See application note 2.

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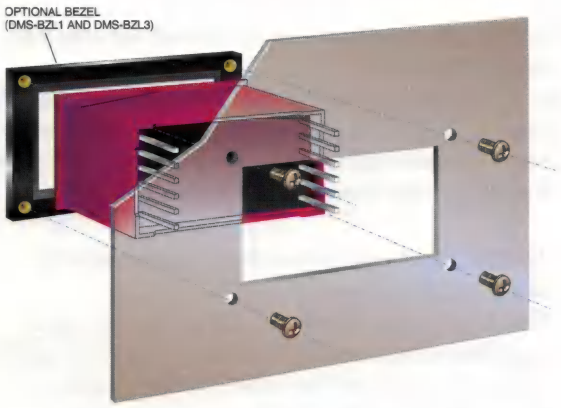
INNOVATION and EXCELLENCE

DMS APPLICATION NOTE 16

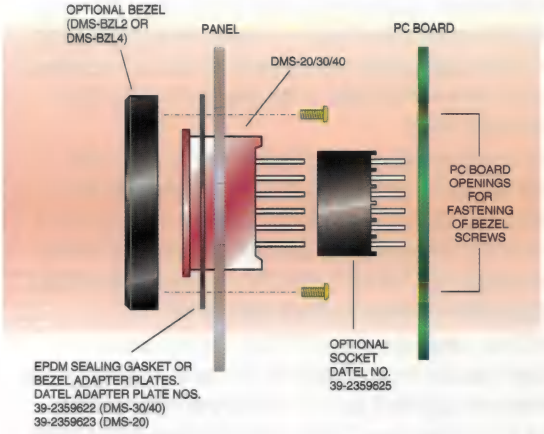
Typical Meter Installations

The unique packaging of DMS Series panel meters makes them ideal for use in traditional panel-mount applications and not-so-traditional printed circuit board applications. This application note illustrates the more popular methods of panel mounting DATEL's state-of-the-art digital panel meters. The illustrations shown are generic in nature and apply to all DMS-20/30/40 meters and 2-wire instruments. Panel cutout and drill dimensions are shown in the individual product data sheets.

Bezel Assembly and PC Board Mounting



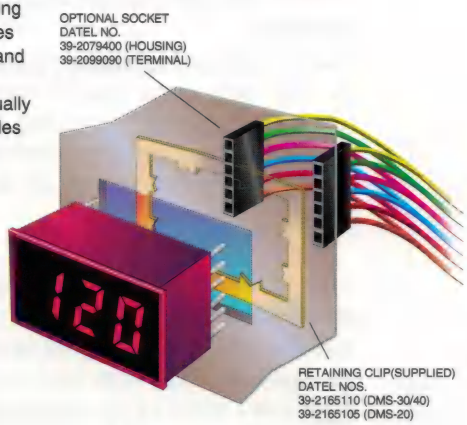
Four ABS-plastic bezel assemblies are available (see Ordering Guides) for aesthetics or environmentally-demanding applications. For those applications requiring moisture and/or dust resistance, two bezels are offered with EPDM sealing gaskets. The gasket is installed around the meter and seals the perimeter of the bezel/meter/panel interface. For added durability, all bezels feature threaded metallic screws and inserts.



Two adapter plates are available enabling DMS meters to be installed in irregular, "less-precise" panel cutouts. These plates can also be used to compensate for larger cutouts encountered when designing-in DATEL meters as alternate sources. Contact DATEL for details. The use of board-mounted sockets simplifies installation and provides the necessary support for less-demanding applications. Make sure the sockets are designed to accommodate the meter's 0.025" square, solder-plated pins.

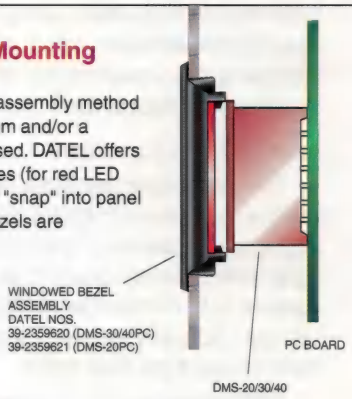
Retaining Clip Mounting

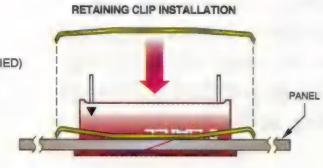
The preformed, metal retaining clip supplied with DMS Series meters implements a quick and secure, cost-effective panel mounting method. The manually installed retaining clip provides a smooth, flush-mounted installation that occupies a minimal amount of front panel real estate.



Behind-the-Panel Mounting

Many customers use this assembly method when space is at a premium and/or a custom panel overlay is used. DATEL offers windowed bezel assemblies (for red LED meters only) which simply "snap" into panel cutouts. Two windowed bezels are available.





For a complete list of DATEL Panel Meter Accessories, see page 5-16.

6

DATEL® INNOVATION and EXCELLENCE

DMS APPLICATION NOTE 17

Introduction to 2-Wire Meters

What Is a 2-Wire Meter?

A 2-wire "self-powered" meter, as its name implies, needs only two input connections to perform its required function. All operating power is supplied solely by the signal being measured. Most engineers and technicians are familiar with analog-readout, 2-wire, pointer-style gauges—from the ammeters and voltmeters in their car's instrument cluster, to the reliable VOM (Volt-Ohm-Meter) on their bench.

The analog gauge's operation is straightforward. A small electrical current carried by two wires sets up a magnetic field in a coil which in turn causes a needle pointer inside the gauge to be proportionately deflected in one direction or another. All of these pointer-style gauges normally have only a positive terminal and a negative terminal—hence the 2-wire designation.

Until now, users who needed a more accurate and easy-to-read digital readout for a parameter as simple as a dc voltage had to contend with a general-purpose digital panel meter's (DPM) maze of input connections. There were connections for the power supply, connections for the signal source, connections for signals called "Analog Common" and/or "Power Common", connections for decimal points, etc., etc.

To make matters worse, many DPM vendors' data sheets did little to simplify the installation by using phrases like "single-ended inputs only" or "observe common mode voltage limitations." These phrases, while in themselves not very complex, only helped to further confuse the situation. Getting the meter to function properly frequently involved several calls to the vendor's applications engineering staff—assuming they had a staff—and the costly "sacrificing" of a meter or two.

Enter the 2-Wire Digital Meter

The scenario described above had become all-too-familiar to DATEL's Applications and Design Engineers. There had to be a simpler way to make everyday ac and dc measurements with digital meters. Our Applications Engineers' never-ending tales of customer woes, combined with DATEL's proprietary low-power LED and LCD display technology, inevitably led to the development of 2-wire digital panel meters.

DATEL's new line of 2-wire meters can replace older, less-precise analog meters in many applications. 2-wire meters, in both LED and LCD display versions, are now available for monitoring the following signals: ac voltages from 85 to 600Vac; positive and negative dc voltages from 2 to 264Vdc; ac frequencies from 47 to 450Hz; and 4-20mA inputs from all manner of process monitoring instrumentation. The following section answers the most frequently asked questions (FAQ's) we receive regarding the operation of these revolutionary 2-wire meters.

2-Wire Meter FAQ's (Frequently Asked Questions)

Question: Do digital 2-wire meters still function when their inputs go to zero?

No. All digital instruments require a minimal amount of power to drive their internal electronics. However, the input level at which 2-wire instruments stop functioning is normally well below the level at which the system being monitored has stopped functioning.

Question: What happens when the input goes below the minimum specified level?

The answer to this question is model dependent. LCD display models will normally continue to operate well below their specified minimum input levels, but the display's contrast will gradually diminish, and more importantly, the readout accuracy is no longer guaranteed.

For LED display models, the intensity of the display will diminish, but the readout will remain fairly accurate down to the level at which the display becomes so dim that it becomes unreadable. In applications in which the display is required to be totally off at times, be sure to drive the meter with components which bring the input signal all the way to zero.

Question: Why aren't absolute maximum input ratings specified?

Absolute maximum input levels are specified on our data sheets as the "Input Voltage Range" or simply "Input Range". This rating is the meter's maximum *continuous* operating level at the highest-rated operating temperature. In practical applications, momentarily exceeding the input range by 10% will not harm any of our 2-wire meters.

Question: What happens when a 2-wire meter's input signal polarity is reversed?

Absolutely nothing—the display will not operate. Except for ac-mains powered devices whose inputs are not polarity sensitive, all DATEL 2-wire meters are fully protected against reversed-polarity inputs (i.e., "input signals that are hooked up backwards").

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DMS APPLICATION NOTE 18

Recommended Component Suppliers

The following companies' products have either been used by DATEL or recommended to us by our customers. All have proven track records. We hope this information saves you time and money. Unfortunately, many companies have minimum order requirements which can frustrate the prototype-building process. This can sometimes be overcome by requesting samples. It does no harm to ask! If the sample approach does not work, ask for the nearest authorized distributor. In many cases, they have more liberal sample policies and/or lower minimum order quantities.

DC CURRENT SHUNTS (Terminal Block Style, 0-30,000 Amperes)
Empro Manufacturing Co., Inc.
P.O. Box 26060
Indianapolis, IN 46226 USA
Tel: 317-823-4478 Fax: 317-823-4835
internet: **www.thomasregister.com**

DC CURRENT SHUNTS (PC Board Mount Style, 0-20 Amperes)
ISOTEK Corp.
566 Wilbur Ave.
Swansea, MA 02777 USA
Tel: 508-673-2900 Fax: 508-676-0885
Internet: **www.isotekcorp.com**

ISOTEK products are suitable for use in precision, current-sensing instrumentation. Shunts are available in leaded and SMT styles.

DC /DC CONVERTERS
DATEL, Inc.
11 Cabot Boulvard
Mansfield, MA 02048-1151 USA
Tel: 508-339-3000 Fax: 508-339-6356
Internet: **www.datel.com**

PANEL MOUNT CONNECTORS
Molex
2222 Wellington Court
Lisle, IL 60532 USA
Tel: 800-786-6359 Fax: 630-968-8356
Internet: **www.molex.com**

Molex products are available through many distributors (including Digi-Key) throughout the world.

PC BOARD SOCKETS AND ACCESSORIES
Samtec, Inc.
P.O. Box 1147
New Albany, IN 47151-1147 USA
Tel: 812-944-6733 Fax: 812-948-5047
Internet: **www.samtec.com**

Samtec also manufactures pre-wired insulation displacement connectors (IDC's) that are useable with most DMS meters.

PRECISION RESISTORS (± 0.1% to ± 0.5%)
Precision Resistive Products, Inc.
202 Mack Lane
Mediapolis, IA 52637 USA
Tel: 319-394-9131 Fax: 319-394-9280
Internet: **www.prpinc.com**

PRP carries leaded precision resistors. High-voltage and custom values are also available.

PRECISION VOLTAGE CALIBRATORS
Calibrators Inc.
26 Oxford Road
Mansfield, MA 02048 USA
Tel: 508-337-3001 Fax: 508-337-6488
Internet: **www.calibratorsinc.com**

Calibrators Inc. manufactures high-precision voltage sources suitable for calibrating and/or verification of DMS Series meters.

VOLTAGE REGULATORS (Three Terminal, LM7805)
Digi-Key Corp.
P.O. Box 677
701 Brooks Ave. South
Thief River Falls, MN 56701-0677 USA
Tel: 800-344-4539
Internet: **www.digikey.com**

Digi-Key also carries a wide selection of ±1% resistors, potentiometers, capacitors, coils, connectors, etc.

Part Number Index

Model	Page
39-0276600	5-17
39-0276610	5-17
39-0276715	5-17
39-0304000	5-17
39-2068200	5-16
39-2068235	5-16
39-2079400	5-16
39-2099000	5-16
39-2099090	5-16
39-2165105	5-16
39-2165110	5-16
39-2359513	5-16
39-2359550	5-16
39-2359620	5-16
39-2359621	5-16
39-2359622	5-16
39-2359623	5-16
39-2359624	5-16
39-2359625	5-16
DMS-20-CP	5-16
DMS-20LCD-0-5	1-15
DMS-20LCD-0-5B	1-15
DMS-20LCD-0-9	1-15
DMS-20LCD-0-9B	1-15
DMS-20LCD-0-DCM	3-7
DMS-20LCD-1-5	1-15
DMS-20LCD-1-5B	1-15
DMS-20LCD-1-9	1-15
DMS-20LCD-1-9B	1-15
DMS-20LCD-1-DCM	3-7
DMS-20LCD-2-5	1-15
DMS-20LCD-2-5B	1-15
DMS-20LCD-2-9	1-15
DMS-20LCD-2-9B	1-15
DMS-20LCD-3-5	1-15
DMS-20LCD-3-5B	1-15
DMS-20LCD-3-9	1-15
DMS-20LCD-3-9B	1-15
DMS-20LCD-4/20S	4-6
DMS-20PC-0/5-24RL	4-17
DMS-20PC-0/5-5GS	4-17
DMS-20PC-0/5-5RH	4-17
DMS-20PC-0/5-5RL	4-17
DMS-20PC-0/5-5RS	4-17
DMS-20PC-0-DCM	3-8
DMS-20PC-0-AS	1-3
DMS-20PC-0-GS	1-3
DMS-20PC-0-GS-H	1-3
DMS-20PC-0-OS	1-3
DMS-20PC-0-RH	1-3
DMS-20PC-0-RL	1-3
DMS-20PC-0-RS	1-3
DMS-20PC-0-RS-H	1-3
DMS-20PC-0-YS	1-3
DMS-20PC-1-AS	1-3
DMS-20PC-1-DCM	3-8
DMS-20PC-1-FM	3-6
DMS-20PC-1-FM-F	3-6
DMS-20PC-1-GS	1-3
DMS-20PC-1-GS-H	1-3
DMS-20PC-1-LM	3-3
DMS-20PC-1-LM-F	3-3
DMS-20PC-1-LM-R	3-3
DMS-20PC-1-OS	1-3
DMS-20PC-1-RH	1-3
DMS-20PC-1-RL	1-3
DMS-20PC-1-RS	1-3
DMS-20PC-1-RS-H	1-3
DMS-20PC-1-YS	1-3
DMS-20PC-2-AS	1-3
DMS-20PC-2-DCM	3-8
DMS-20PC-2-FM	3-6
DMS-20PC-2-GS	1-3
DMS-20PC-2-GS-H	1-3
DMS-20PC-2-LM	3-4
DMS-20PC-2-OS	1-3
DMS-20PC-2-RH	1-3
DMS-20PC-2-RL	1-3
DMS-20PC-2-RS	1-3
DMS-20PC-2-RS-H	1-3
DMS-20PC-2-YS	1-3
DMS-20PC-3-AS	1-3
DMS-20PC-3-DCM	3-9
DMS-20PC-3-FM	3-6
DMS-20PC-3-GS	1-3
DMS-20PC-3-LM	3-5
DMS-20PC-3-OS	1-3
DMS-20PC-3-RH	1-3
DMS-20PC-3-RL	1-3
DMS-20PC-3-RS	1-3
DMS-20PC-3-RS-H	1-3
DMS-20PC-3-YS	1-3
DMS-20PC-4-DCM	3-10
DMS-20PC-4/20S	4-3
DMS-20PC-5-DCM	3-10
DMS-20PC-6-DCM	3-10
DMS-20PC-7-DCM	3-11
DMS-30-CP	5-16
DMS-30193	1-27
DMS-30194	1-27
DMS-30195	1-27
DMS-30LCD-0-5	1-21
DMS-30LCD-0-5B	1-21
DMS-30LCD-0-9	1-21
DMS-30LCD-0-9B	1-21
DMS-30LCD-1-5	1-21
DMS-30LCD-1-5B	1-21
DMS-30LCD-1-9	1-21
DMS-30LCD-1-9B	1-21
DMS-30LCD-2-5	1-21
DMS-30LCD-2-5B	1-21
DMS-30LCD-2-9	1-21
DMS-30LCD-2-9B	1-21
DMS-30LCD-3-5	1-21
DMS-30LCD-3-5B	1-21
DMS-30LCD-3-9	1-21
DMS-30LCD-3-9B	1-21
DMS-30LCD-4/20S	4-7
DMS-30PC-0-AS	1-9
DMS-30PC-0-BS	1-9
DMS-30PC-0-GL	1-9
DMS-30PC-0-GS	1-9
DMS-30PC-0-OL	1-9
DMS-30PC-0-OS	1-9
DMS-30PC-0-QS	1-9
DMS-30PC-0-RH	1-9
DMS-30PC-0-RL	1-9
DMS-30PC-0-RS	1-9
DMS-30PC-0-YS	1-9
DMS-30PC-1-AS	1-9
DMS-30PC-1-BS	1-9
DMS-30PC-1-GL	1-9
DMS-30PC-1-GS	1-9
DMS-30PC-1-OL	1-9
DMS-30PC-1-OS	1-9
DMS-30PC-1-QS	1-9
DMS-30PC-1-RH	1-9
DMS-30PC-1-RL	1-9
DMS-30PC-1-RS	1-9
DMS-30PC-1-YS	1-9
DMS-30PC-2-AS	1-9
DMS-30PC-2-BS	1-9
DMS-30PC-2-GL	1-9
DMS-30PC-2-GS	1-9
DMS-30PC-2-OL	1-9
DMS-30PC-2-OS	1-9
DMS-30PC-2-QS	1-9
DMS-30PC-2-RH	1-9
DMS-30PC-2-RL	1-9
DMS-30PC-2-RS	1-9
DMS-30PC-2-YS	1-9
DMS-30PC-3-GS	1-9
DMS-30PC-3-RL	1-9
DMS-30PC-3-RS	1-9
DMS-30PC-4/20S-24RL	4-12
DMS-30PC-4/20S-5GS	4-12
DMS-30PC-4/20S-5RH	4-12
DMS-30PC-4/20S-5RL	4-12
DMS-30PC-4/20S-5RS	4-12
DMS-40LCD-0/1-5	2-9
DMS-40LCD-0/1-5B	2-9
DMS-40LCD-0/1-9	2-9
DMS-40LCD-0/1-9B	2-9
DMS-40LCD-1/2-5	2-9
DMS-40LCD-1/2-5B	2-9
DMS-40LCD-1/2-9	2-9
DMS-40LCD-1/2-9B	2-9
DMS-40LCD-2/3-5	2-9
DMS-40LCD-2/3-5B	2-9
DMS-40LCD-2/3-9	2-9
DMS-40LCD-2/3-9B	2-9
DMS-40LCD-4/20S	4-10
DMS-40PC-1-GS	2-3
DMS-40PC-1-RH	2-3
DMS-40PC-1-RL	2-3
DMS-40PC-1-RL-BCD	2-3
DMS-40PC-1-RS	2-3
DMS-40PC-1-RS-BCD	2-3
DMS-40PC-1-YS	2-3
DMS-40PC-2-GS	2-3
DMS-40PC-2-RH	2-3
DMS-40PC-2-RL	2-3
DMS-40PC-2-RL-BCD	2-3
DMS-40PC-2-RS	2-3
DMS-40PC-2-RS-BCD	2-3
DMS-40PC-2-YS	2-3
DMS-40PC-3-GS	2-3
DMS-40PC-3-RH	2-3
DMS-40PC-3-RL	2-3
DMS-40PC-3-RL-BCD	2-3
DMS-40PC-3-RS	2-3
DMS-40PC-3-RS-BCD	2-3
DMS-40PC-3-YS	2-3
DMS-40PC-4/20S-24RL	4-15
DMS-40PC-4/20S-5GS	4-15
DMS-40PC-4/20S-5RH	4-15
DMS-40PC-4/20S-5RL	4-15
DMS-40PC-4/20S-5RS	4-15
DMS-BZL1	5-16
DMS-BZL2	5-16
DMS-BZL3	5-16
DMS-BZL4	5-16
DMS-EB	5-6
DMS-EB-AC/DC	5-9
DMS-EB-DC/DC	5-10
DMS-EB-HTBC	5-11
DMS-EB-HTBF	5-11
DMS-EB-LP	5-12
DMS-EB-RMS	5-14
DMS-EB-TCJ	5-15
DMS-EB-TCK	5-15
DMS-EB2	5-3
DSD-40BCD-GS	2-15
DSD-40BCD-RL	2-15
DSD-40BCD-RS	2-15
RN-DMS	5-16
UPA-12/200	5-16
UPA-5/500	5-16

General Disclaimer

In accordance with our policy of continuous product improvement, DATEL, Inc. reserves the right to make changes/improvements to our products and/or their specifications at any time without prior notice to anyone. Prices are also subject to change without notice.

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DATEL products are not designed for and should not be used, without the specific prior written consent of DATEL, Inc., in any life-support systems, nuclear-facility applications, aircraft-control applications or any other applications in which failure of the product, in any way, could reasonably result in harm to life, property or the environment.

A life-support system is defined as a product or system intended to support or sustain life and whose failure can be reasonably expected to result in significant personal injury or death. Nuclear-facility applications are defined as any application involving a nuclear reactor or the handling and processing of radioactive materials in which the failure of equipment, in any way, could reasonably result in harm to life, property or the environment.

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Tel: (508)339-3000, (800)233-2765 Fax: (508)339-6356 • Email: sales@datel.com • Internet: www.datel.com

Placing an Order

When ordering a DATEL product, use the complete model number (including any part-number suffixes indicating product options) as well as a description of the product and its options. You may enter orders by telephone, FAX or letter directly with Company Headquarters (Mansfield, MA, U.S.A.) or with any authorized DATEL field sales representative. Minimum order value and minimum per shipment amount are both $100. We also accept VISA, Mastercard and American Express credit cards as a payment option.

Outside the U.S.A. and Canada

Place overseas orders directly with a DATEL Sales Subsidiary Office (in Germany, France, the United Kingdom or Japan) or with an authorized DATEL sales representative. International orders received directly at DATEL Headquarters in the U.S.A. will be treated as if placed through the appropriate overseas representative. In countries without a local DATEL representative, orders should be placed directly with Company Headquarters and confirmed by air mail.

Field Sales Representatives

DATEL has direct sales offices in the United States (Mansfield, MA), Germany (Munich), France (Montigny Le Bretonneux), England (Tadley) and Japan (Tokyo and Osaka). We employ an extensive network of field sales representatives throughout the U.S.A., Canada, Europe, the Far East and other areas of the world. Only these sales representatives are authorized by DATEL to solicit sales, and any information or data received from sources other than DATEL or its authorized representatives is not considered binding.

Prices

All prices are F.O.B. Mansfield, MA, U.S.A. in U.S. dollars. Applicable federal, state and local taxes are extra and paid by the buyer. Prices are subject to change without notice.

Quotations

Price and delivery quotations made by DATEL or any of its authorized representatives are valid for 30 days unless otherwise stated.

Discounts

Quantity discounts are available when appropriate quantities of products are ordered in a single order. OEM discounts are available on a per-order or contract basis. Consult Company Headquarters or your local representative for quotations or additional details.

Payment Terms

Net 30 days. We also accept VISA, Mastercard and American Express credit cards as a payment option.

Acknowledgements and Delivery

DATEL acknowledges all orders, including delivery and billing information, upon receipt. We ship all products in rugged commercial containers suitable for ensuring safe delivery under normal shipping conditions. Unless shipping specifications accompany an order, we will use the best available method. Shipping charges are normally prepaid by DATEL and billed to the customer except for air-freight shipments which are sent collect. When appropriate, product data sheets and/or instructions are included with each shipment.

Order Cancellation

All orders placed with DATEL are binding and subject to cancellation charges if cancelled either before or after the scheduled shipping date. Refer to DATEL's standard Terms and Conditions for specific charges.

Warranty

DATEL warrants that all of its products are free from defects in material or workmanship under normal use and service for a period of one year from date of shipment. DATEL's obligations under this warranty are limited to replacing or repairing, at our option, at our factory or facility, any of the products which shall within the applicable period after shipment be returned to us, transportation charges prepaid, and which are, after examination, disclosed to the satisfaction of DATEL to be thus defective. The warranty does not apply to any products or equipment which have been repaired or altered, except by DATEL, or which have been subjected to misuse, negligence or accident. Under no circumstances shall DATEL's liability exceed the original purchase price. The aforementioned provisions do not extend the original warranty period of any product which has either been repaired or replaced by DATEL.

Returns

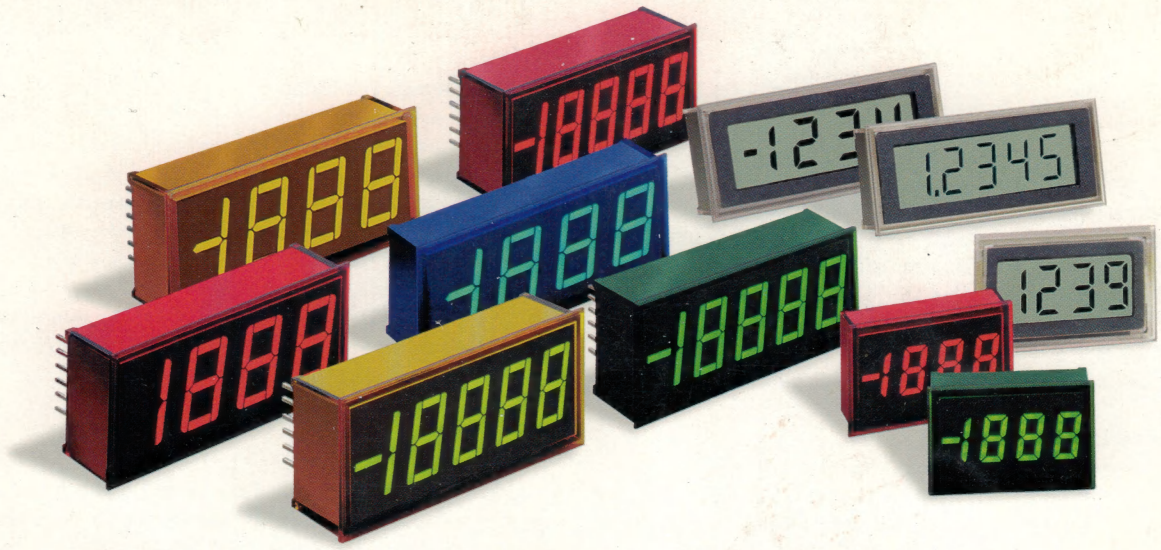
Before returning any products, for any reason, you must receive a return material authorization (RMA) number and shipping instructions from DATEL. Items should not be returned via air freight collect as they will not be accepted. If you do not return materials as directed above, considerable delay will be added to processing the return.

Returns Outside the U.S.A. and Canada

Contact either DATEL Headquarters, a DATEL Sales Subsidiary Office or your local DATEL sales representative for authorization and shipping instructions before returning any materials.

Certificates of Compliance

DATEL will supply a standard Certificate of Compliance when requested to do so by a customer. Requests must be specified on the original purchase order.



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INNOVATION and EXCELLENCE

MADE IN USA